TRUCTION OF DISABLED MEN IN MOTION PICTURE PROJECTION

AN ELEMENTARY TEXT BOOK

By JAMES R. CAMERON
Instructor of Projection
The Red Cross Institute for Crippled and Disabled Men

NEW YORK
THE RED CROSS INSTITUTE FOR
CRIPPLED AND DISABLED MEN
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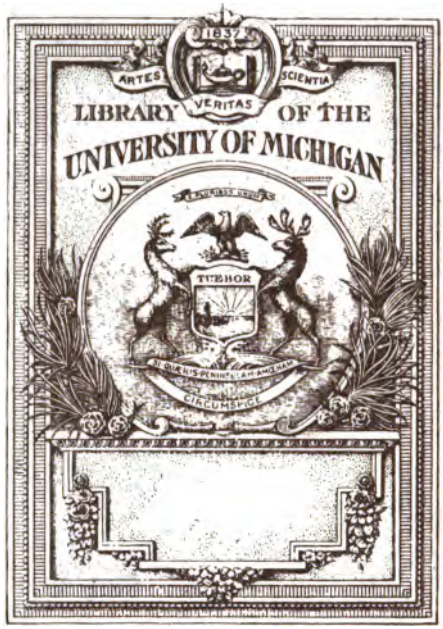

MOTION PICTURE PROJECTION

Various types of motion picture machines in use for instruction of pupils at Red Cross Institute

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ACKNOWLEDGMENT
IS HEREBY MADE TO THE NICHOLAS POWER COMPANY
AND MR. J. H. HALLBERG
FOR THE LOAN
OF
SEVERAL CUTS AND PLATES
USED IN THIS BOOK

INTRODUCTION

Fifteen to twenty years ago the motion picture was regarded as an amusement for children and little else. Today the industry is the fifth largest in the United States. The motion picture now commands the interest and attention of leaders in every field of endeavor and it is judged by the high standards that are applied to the other arts.

The development of the motion picture in mechanical and artistic perfection has brought about a corresponding demand for highly skilled projectionists. The poorly projected film, notwithstanding the thought, expense, and effort expended in its making, is stamped as a failure. The man who stands in the booth "and merely turns the crank" is as obsolete as the "Nickelodeon." Into his place has stepped an artisan—a man trained in applied electricity, optics, the theory of light, and the manifold complications that are entailed in successful projection. No man is permitted to operate the machine unless he has a city license, which means that he must pass a thorough examination before he can go to work.

The need for schools to train motion picture projectors is greater at the present time than ever. Manufacturers and exhibitors state that there is a scarcity of good projectionists, and they offer ready and profitable employment to qualified men.

The shortage of labor caused by the war pointed out the necessity as well as the wisdom of utilizing every possible unit of productivity. The experience of the European belligerents proved that it is possible to train cripples for trades in which their physical handicaps do not debar them from competing successfully with the able-bodied. Soon after America's entry into the war, a group of far-seeing men realized the need of providing training for the cripples of industry so that the experience thus gained might serve as a basis for the re-education of the returned disabled soldier.

The effort of these men culminated in the establishing in New York City of the Red Cross Institute for Crippled and Disabled Men, under the auspices of the American Red Cross. Departments of industrial surveys, research, employment and public education were inaugurated and the foundation of the first special non-commercial training school for the physically handicapped in the United States was built. Classes in the manufacture of artificial limbs, mechanical drafting, printing, jewelry making, and oxy-acetylene welding were begun and in May, 1918, a course in motion picture operating was introduced with James R. Cameron as instructor.

The choice of motion picture projecting as a trade for the cripple was based on the knowledge that it was one of the growing trades, that in England and France the cripple had made good as a projectionist, that the wages were good, that working conditions were favorable, and that almost any man with both hands intact could, with a course of study of about two months in duration, acquire sufficient knowledge to enable him to

enter an operating booth, and take charge of the machines.

About twelve pupils responded to roll call during the first days of the class at the Red Cross Institute. Most all were leg cases, either paralysis or amputation. Most of the men had to support themselves while learning but they applied their energies to their task and made rapid progress. With one exception, all of the men who have taken up this course have passed the municipal examination, and have secured positions through the Institute, and what is more to the point, every one of them has made good on the job. The first graduate of the class earned sixty-two dollars during his first week of actual employment, and the salaries of the others averaged about thirty-five dollars per week.

The course of study in the motion picture operating class in the Red Cross Institute is designed to be as thorough as possible. The pupil receives training in:

(*a*) *Elementary Electricity.*
(*b*) *The Application of Electricity to an Arc Lamp.*
(*c*) *The Construction, Care and Use of Electrical Appliances, such as Transformers, Mercury Arc Rectifiers, Rheostats, Motor Generators, Storage Batteries, etc.*
(*d*) *Optics—Construction of Lenses.*
(*e*) *Theory of Light.*
(*f*) *Construction and Care of Projecting Machines.*
(*g*) *Handling, Care and Repairing of Films.*

The aim of the course is not only to fit a man to take the city examination for a license, but to give him a

good working knowledge of actual projection. He must make a certain grade in his work both in theory and practice before the Institute permits him to apply for his license.

The equipment at the disposal of the students in the Institute was generously loaned by the Nicholas Power Company, the Simplex Machine Company, the United Theatre Equipment Corporation through its President Mr. Hallberg, Mr. William Fox, Mr. B. F. Wyler, and others. It is valued at nine thousand dollars and consists of everything necessary to a mastery of the art of projection.

The equipment includes the following:

Power's Motor Driver Projection Machine.
Simplex Machine installed in Asbestos Booth.
Acme Portable Machine equipped with Mazda Lamp.
Cosmograph Portable Machine with Pencil Arc.
Hallberg Motor Generator.
Hallberg Economizer.
Hallberg Regulator for Mazda Lamp.
Step-Up and Step-Down Transformers.
Rheostats.
Mercury Arc Rectifier.
Stereopticons.
Distributing Board fitted with the various House Wiring Systems, Ammeters and Voltmeters.
Various makes of Screens.
Film Measuring, Cleaning and Re-winding Machines.
Vivatarg Apparatus.

VIVATARG APPARATUS

A new motion picture projection machine whose mechanism is automatic and controlled by sound waves created by the voice, the clapping of hands, or other noises, reports by explosions, etc., was recently installed in the Red Cross Institute. The sound waves are recorded by a telephone receiver connected to a system of control, which, instantly a sound is made by the voice, etc., brings the motion picture to a stop; after a pre-determined period of from one second to one hour, if desired, the picture on the screen resumes its motion.

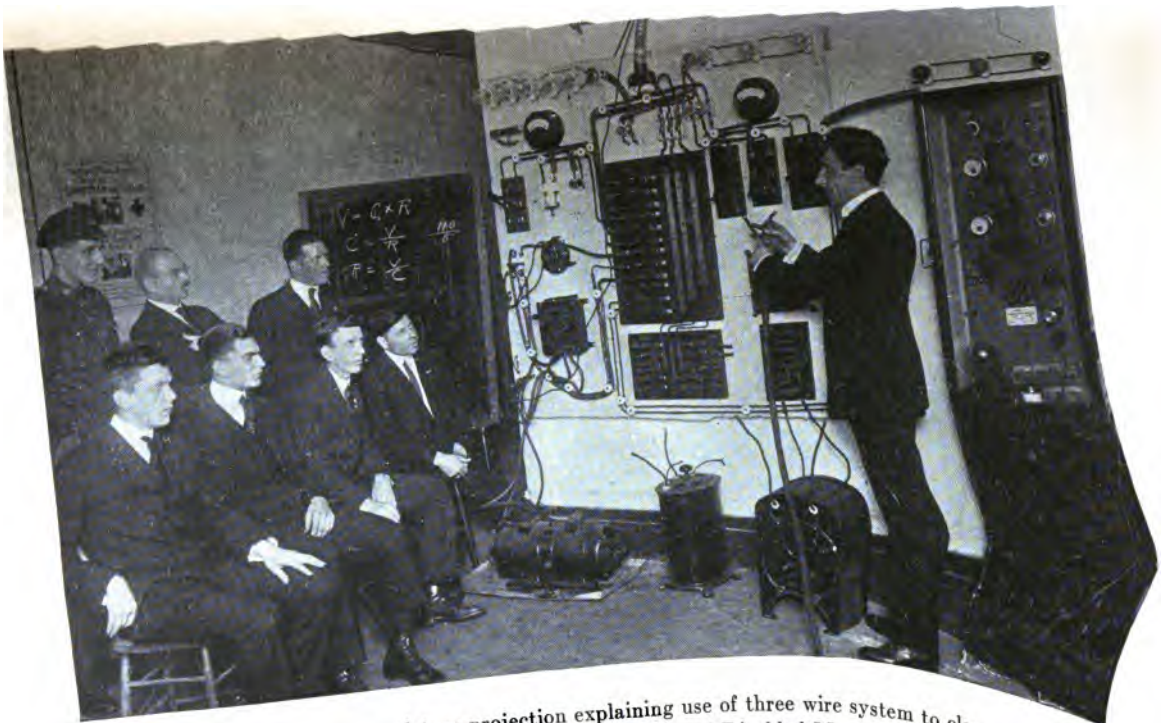
The Vivatarg is electrically operated and automatically controlled. It is especially useful in connection with lectures and practical demonstrations of surgical and dental operations and of the construction of special apparatus, for the picture can be brought to a sudden halt to enable the lecturer to explain his point in detail. To accomplish this, the inventor had three obstacles to overcome: (1) to stop the picture *instantly* at any given point; (2) to hold the picture *still* on the screen for any desired period; and, (3) to *prevent the burning* of the film while held stationary. The Vivatarg performs all three functions successfully. It is a mechanism that offers an almost unlimited field for experimentation. The Vivatarg in the Institute is one of three machines of the same type in existence.

A FUTURE OF PROMISE

From the beggar's cup, the pack of pencils, or the "blind alley" job of watchman or messenger to the

position of motion picture projector—from charity to self-support—that is the road that many cripples have been encouraged to take. If the public will help the cripple to "come back," if they will regard him as a person with the same ambition and the same right to an opportunity to succeed as the normal man; if the employer will give the cripple a chance to make good on the basis of competency alone—not charity—the future that awaits those of our soldiers who return disabled is bright with possibilities.

HARRY BIRNBAUM
Red Cross Institute for Crippled and Disabled Men



Instructor in motion picture projection explaining use of three wire system to class at Red Cross Institute for Crippled and Disabled Men

Powers Cameragraph No. 6B

ELECTRICAL TERMS

It is necessary for the projectionist to thoroughly understand the following electrical terms:

Electric Motive Force. Another name for voltage or pressure. Generally written E. M. F. The volt is the unit of E. M. F.

Ampere. The unit of current strength. The quantity of current flowing through a circuit.

Ohm. The unit of resistance. The term used to measure the opposition offered to the flow of an electric current. The amount of resistance offered by a column of mercury 106 centimeters in length by one square millimeter in cross section, at a temperature of zero centigrade.

Direct Current. A current that flows in the one direction. Written D. C.

Alternating Current. A current that changes its flow of direction so many times a second according to the construction of the alternator. Written A. C.

Conductor. Anything that will permit the passage of electricity. A wire.

Rubber Covered Wire. A cable either solid or stranded with a rubber covering and an outer protective covering of cotton braid. Used for mains for motion picture work.

Asbestos Covered Wire. A cable containing very fine strands of copper wire all twisted together and covered with an asbestos covering. Used wherever heat is generated. On motion picture circuits used between the table switch and arc lamp.

Stage Cable. A cable containing twin conductors each insulated from the other and the whole thing covered with a composition covering. Used for temporary purposes.

B. X. Metal tubing containing two conductors, each conductor insulated from the other by a rubber covering, and both wires wrapped with a composition covering so as to completely fill the tubing.

Ammeter. An instrument used in your circuit to measure the flow of amperes. Connected in series.

Voltmeter. An instrument used in your circuit to measure the pressure or voltage. Connected in multiple.

Laminated. Made up of a number of thin iron sheets.

Current Frequency. The number of times alternating current changes its flow of direction a second. The changes are called cycles.

Sixty Cycle A. C. This is when every part of the circuit is 60 times positive and 60 times negative every second. The current changes its flow of direction 60 times a second.

Induction. The property of a charged body on A. C. to charge a neighboring body running parallel to it without any tangible form of connection.

Watt. The unit of power. The product of one ampere and one volt.

Kilowatt. 1,000 watts (written K. W.) or 1.34 horse power as 746 watts equal one horse power.

Circular Mil. The unit of area. A mil is the one-thousandth part of an inch and a circular mil is the area of a circle whose diameter is one mil. The cross section of wires is measured by circular mils.

Short Circuit. Two wires of opposite polarity coming in contact with each other without any controlling device.

Ground. Caused by the connection of an electrical conductor to a conducting medium other than that to which it belongs.

Polarity. Pertaining to the two opposite poles of a circuit; the positive and negative.

Transverter. A motor generator set, an A. C. or D. C. motor connected to a D. C. generator.

Secondary Coil. The coil of a transformer in which the current is induced, connected to the lamp.

Primary Coil. The coil of a transformer that is connected to the source of supply.

Inductor. A step-down transformer.

Economizer. A step-down transformer.

Converter. An apparatus used to change A. C. to D. C. or D. C. to A. C.

Step-Down Transformer. A transformer that steps down the voltage and raises the amperage.

Step-Up Transformer. A transformer that steps up the voltage and lowers the amperage.

Arc Rectifier. An apparatus used to change A. C. to D. C.

Auto Transformer. A transformer provided with only one coil instead of two. Part of the coil being traversed by the primary circuit and part being traversed by the secondary circuit.

Dimmer. An adjustable rheostat for increasing or decreasing the resistance in an incandescent lamp circuit.

Insulation. Any material of high resistance through which electric current cannot pass. Rubber, mica, glass and porcelain are all insulating materials.

Lug. A wire terminal. These lugs should always be soldered on the end of the wires except when such wires are to be used where heat is generated. A special lug is used under these conditions which is tightened on wire by the pliers. No solder should be used on lugs that are used on the rheostat or in lamp house.

Watt Hour. The amount of work done by one ampere at a pressure of one volt in one hour.

Ampere Hour. The amount of amperes flowing multiplied by the time in hours. One ampere flowing for one hour equals one ampere hour. Two amperes flowing for one-half hour equals one ampere hour. One-half ampere flowing for two hours equals one ampere hour.

Coulomb. The amount of amperes passing in a second. The product of amperes times seconds.

Knife Switch. A switch with knife-like blades used on circuits carrying heavy currents.

Negative. A term used to denote the pole of a source of electricity where the current enters.

Safety Plug. A metal plug which is readily fusible when an abnormal current passes, used as a safety device.

Negative Pole. The terminal of a source of electricity at which the current enters after having passed through the external circuit.

Positive Pole. The terminal from which the current seems to start in traversing the external circuit.

Series. An arrangement or connection of electrical devices in a circuit so that the current will pass successively from one to the next and so on through all, as distinguished from a parallel or multiple arrangement, in which each device is connected directly to the mains, or terminals of the source of supply instead of being connected thereto through the other devices.

Insulating Tape. A ribbon of some flexible material impregnated with rubber or other suitable non-conductor and used for insulating wires, joints and exposed places.

Positive Wire. The wire connected with the positive pole of a dynamo.

Negative Wire. The wire by which a current returns to its source after completing the circuit.

Induced Current. The current produced in a conductor by cutting magnetic lines of force.

Graphite. A soft variety of carbon, sometimes used for lubrication.

Alternator. The name commonly given to an alternating current dynamo.

Armature. The part of the dynamo in which the current is induced, and which may be either stationary or moving. It is placed near the poles of the field magnet. The armature proper of a dynamo is usually a mass of iron upon which are wound coils of insulated wire.

Armature Core. The mass of iron or other magnetizing material upon which the coils of an armature are wound.

Switch Board. A board provided with switches which open, close, or interchange circuits.

Wheatstone Bridge. A device for measuring resistance.

Dynamo Brush. Strips of metal or a plate of metal or of carbon which bears upon the commutator of a dynamo and takes off the current to the circuit.

Brush Holder. A device for holding the brush of a dynamo or motor in position.

Commutator. That part of the dynamo or motor which changes the direction of the current. In a dynamo the current in a given section of the armature alternates, and must be made continuous on leaving it. This is done by the commutator, which consists of insulated metal bars connected with the armature wires and placed so as to feed into different brushes as the current changes.

Transforming a Current. Changing the electric motive force of a current by its passage through a converter or transformer.

Efficiency of Dynamo. The total electric energy developed by a dynamo, divided by the total mechanical energy required to drive the dynamo.

Electric Efficiency. The useful electrical energy from any source, divided by the total consumed energy.

Magnetic Field. The region of magnetic influence surrounding the poles of a magnet.

Filament. In an incandescent lamp the thread of wire or carbon which becomes luminous under the heating effect of an electric current passing through it.

Magnetic Force. The force which causes the attractions or repulsions of magnetic poles.

Horse Power. (Written H. P.) A commercial unit for power or rate of doing work. A rate of doing work equal to raising 550 lbs. one foot in one second, or 33,000 lbs. one foot in one minute, always involves the three factors, force, distance and time. An electrical horse power is 746 watts.

Leads. The conductors used in any system of electric distribution.

Link Fuses. Fuses for electric circuits formed by link-shaped strips of fusible metals.

Magnet. A body possessing the quality of attracting or repelling other bodies.

Pole Finding Paper. Paper used to tell the negative from the positive wire.

Motor Regulator. An adjustable rheostat used to regulate the speed of the motor.

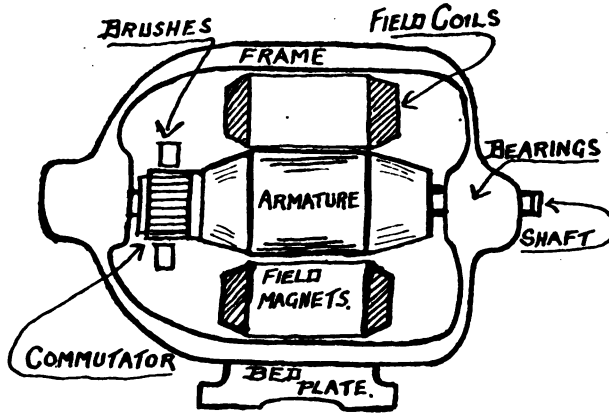
Speed Regulator. An attachment on machine (generally a friction disc arrangement) used to regulate the speed of machine (not the speed of the motor).

Fuse. A safety device used in your circuit to protect your line.

Dynamo or Generator. Used to generate electricity.

Motor Generator. A generator driven by a motor.

Multiple. Multiple connection is when each lamp draws its own supply from the source of supply, and is not depending on any other lamp or set of lamps for supply.



SKETCH OF THE INTERIOR OF A D.C. DYNAMO OR MOTOR.

Class at Red Cross Institute observing operation of machine and actual picture on screen

Powers Cameragraph No. 6A
Showing film threaded through machine

PARTS ON THE HEAD OF MACHINE

Upper Magazine	Centrifugal Movement
Lower Magazine	Idlers
Upper Fire Trap	Tension Springs
Lower Fire Trap	Film Runners
Upper Fire Shield	Balance Wheel
Lower Fire Shield	Take-up
Upper Sprocket	Lens
Lower Sprocket	Gears
Intermittent Sprocket	Spindles
Intermittent Movement	Automatic Shutter
Flicker or Light Shutter	Framing Device
Gate	Cooling Plate

PARTS ON LAMP HOUSE

Arc Lamp	Dowser
Condensers	Slide Carrier

FIRE PREVENTION DEVICES ON MACHINE

Upper Magazine	Upper Fire Shield
Lower Magazine	Lower Fire Shield
Upper Fire Trap	Automatic Shutter
Lower Fire Trap	Cooling Plate

Automatic Shutter. The shutter covering the film aperture in gate of machine and controlled by the centrifugal or governor movement, is so arranged that the shutter will remain up, so long as the machine is in motion, but should the machine stop for any reason then the shutter falls and cuts off the rays of light from the film in gate. (A fire prevention device.)

Fire Trap. An arrangement of rollers on the upper and lower magazines through which the film is fed, used to prevent the flame, in case of fire, from entering the magazines.

Flicker Shutter. A revolving shutter on head of machine just in front of the projection lens, its use being to cut off the rays of light from screen while the film is in motion in gate.

Cooling Plate. The plate around the film aperture on gate which protects the gate itself from getting overheated from the rays of light from arc lamp.

Intermittent Movement. The movement that drives the intermittent sprocket, generally a four in one movement.

Tension Springs. On gate of machine, used to give the proper tension to film while passing aperture.

Take-up. Generally consists of a split pulley and tension spring, its use is to drive and control the speed and tension of the reel taking up the film in lower magazine.

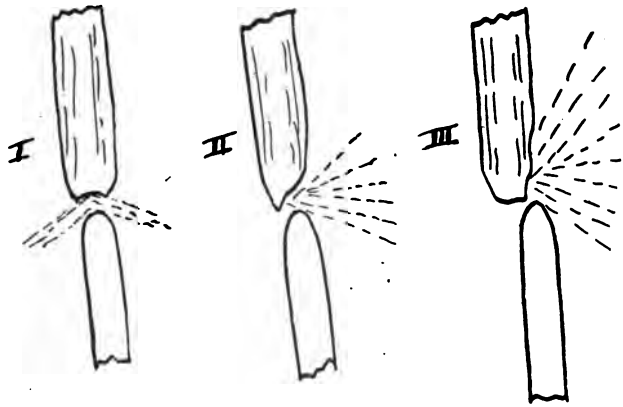
Governor Movement. The movement that works the automatic shutter, works by centrifugal force.

Framing Device. An attachment on the machine which allows the operator to frame the picture on screen.

Condensers. A lens or set of lenses used to gather the rays of light from the arc lamp and bring them to a fixed point of focus on aperture in gate.

Dowser. On front of lamp house, used to cut off the rays of light from the head of machine.

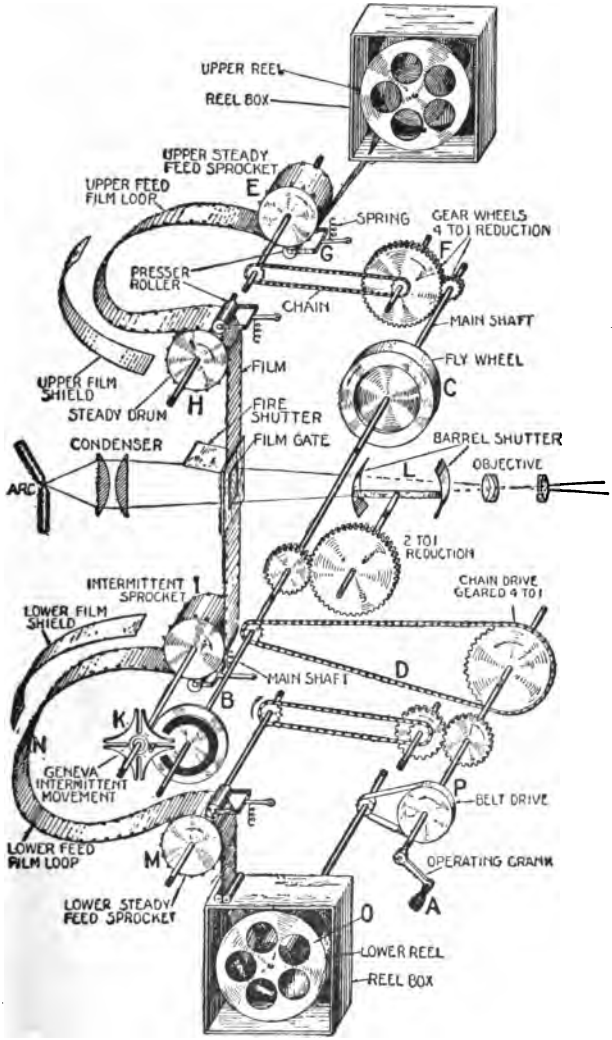
Back Focal Length of Lens. The distance from the back of the lens, to the film in the gate, while the film is in focus on the screen.



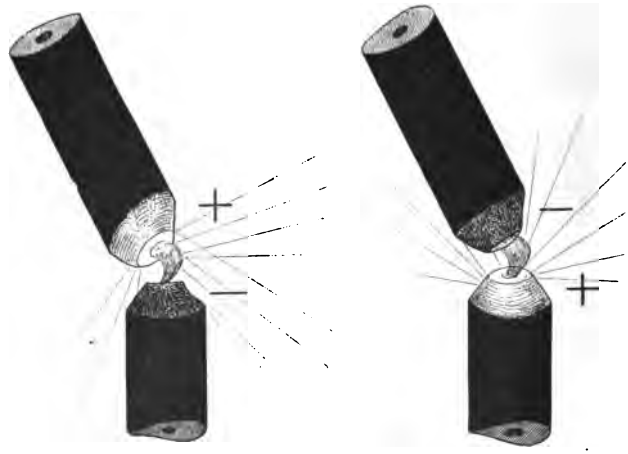
Right and wrong way to set D. C. arc. I. Lower carbon not far enough forward. II. Correct setting. III. Lower carbon too far advanced

WORKING PRINCIPLE OF ELEMENTARY PROJECTION MACHINE

By turning the operating crank *A*, counter clockwise, the main shaft *B*, is driven through the 4 to 1 reduction chain drive *D*, a steady turning motion being caused by the fly wheel *C*, this in turn operates the upper steady feed sprocket *E*, through the 4 to 1 reduction gear *F*, thus the teeth of *E* sprocket which mesh with the perforations in the film, feed the film at a constant rate, the film being held against *E* by pressure roller *G*. A film loop or length of loose film is thus maintained between *E* and the steady drum *H*. The film is fed past the film gate intermittently by the intermittent sprocket *I*, operated by the Geneva movement *K*, the latter producing a quick quarter turn of *I*, followed by a relatively long rest during which the main shaft *B* makes one revolution. The barrel shutter *L*, by a 2 to 1 gear with the main shaft and proper timing, operates to cut off the light rays from the screen during each movement of the intermittent sprocket *I*, and to admit the light during the intervals that *I* remains stationary. The synchronous operation of the intermittent sprocket and the shutter is very clearly shown in the diagram. A lower steady feed sprocket *M*, which operates at the same speed as the upper sprocket *E*, maintains a lower feed film loop *N*, and feeds the film to the lower reel *O*. Because of the increasing diameter of the roll of film due to winding the film on reel *O*, the velocity of rota-


UPPER REEL
REEL BOX
UPPER STEADY FEED SPROCKET
E
UPPER FEED FILM LOOP
SPRING
GEAR WHEELS 4 TO 1 REDUCTION
G
F
PRESSER ROLLER
CHAIN
MAIN SHAFT
FLY WHEEL
FILM
C
UPPER FILM SHIELD
STEADY DRUM
H
FIRE SHUTTER
CONDENSER
FILM GATE
BARREL SHUTTER
OBJECTIVE
L
ARC
2 TO 1 REDUCTION
INTERMITTENT SPROCKET
CHAIN DRIVE GEARED 4 TO 1
LOWER FILM SHIELD
A
MAIN SHAFT
D
B
K
N
GENEVA INTERMITTENT MOVEMENT
P
BELT DRIVE
LOWER FEED FILM LOOP
M
OPERATING CRANK
LOWER STEADY FEED SPROCKET
O
A
LOWER REEL
REEL BOX

tion of *O* must be allowed to vary; this is accomplished by means of the belt drive *P*, the belt permitting slippage below the maximum speed. *It should be carefully noted* that the total revolutions made by each of the three sprockets *E*, *I*, and *M*, is the same, the only difference being that *the motion of E and M is constant while that of I is intermittent.*



Showing effect of arc being connected upside down

THE INTERMITTENT MOVEMENT

PRELIMINARY REMARKS

Too much prominence cannot be given to the intermittent movement of Power's Cameragraph. Before entering into a technical description of this movement, it will be well to give a brief outline of the fundamental principles upon which the art of moving picture projection depends. An understanding of these principles will enable one to better appreciate the very important part that Power's Cameragraph has played in the evolution of the moving picture.

The moving picture is accomplished by flashing a great number of stationary photographic views before the eye in such rapid succession that the eye is deceived into the *belief* of having beheld actual motion.

The photographic views, which are usually taken at the rate of sixteen per second, are printed in direct succession upon a ribbon of *transparent* film one and three-eighths inch in width and between one and two thousand feet in length. Each view is condensed into a rectangular space approximately one inch wide and three-fourths inch high.

When the film is run through the projector at normal speed, sixteen of these views are shown each second. It would appear from this that each view is shown for one-sixteenth of a second. Such is not the case, however. Each view is held stationary before the lens for only a *part* of this minute period of time, and the

remainder of the period is consumed while the film is being moved down a distance of three-fourths of an inch, so as to bring the succeeding view in line with the lens.

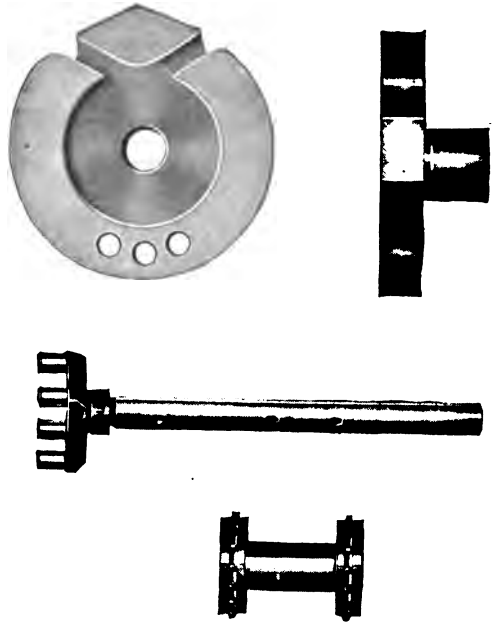


Figure 1

During every such movement of the film, the main blade (or wing) of a revolving shutter, passes in front of the lens, thus preventing any trace of the movements from reaching the screen. If this was not done, the picture would be greatly marred by streaks of light known as "travel ghost." An additional wing (and sometimes two) is inserted in the shutter wheel for the

purpose of doing what is technically known as "equalizing the light." We will not discuss this matter of light equalization as it has no direct bearing upon the point that we wish to bring out.

It is the necessary passage of these wings in front of the lens that prevents an attainment equalling theo-

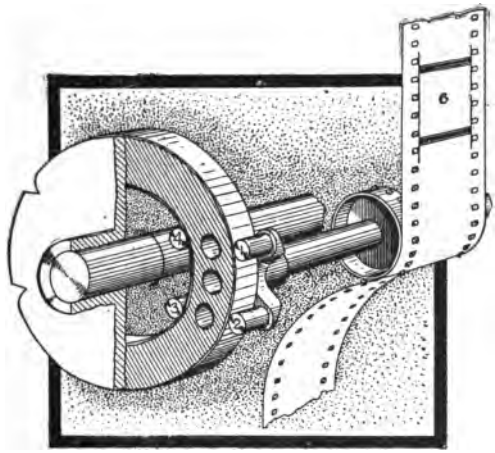


Figure *a*

retical perfection wherein each view would appear on the screen for its entire allotment of one-sixteenth of a second without interruption of any kind.

It would probably be possible to devise a way to move the film so rapidly that the eye could not perceive any trace of the movement, and thus the necessity of using the revolving shutter would be eliminated, but we are prevented from doing this by the very important fact that wear and tear on the film must be taken into

consideration. The movement of the film must not be made so rapidly nor in such a jerky manner as to cause the film to rip or pull apart.

Power's Cameragraph accomplishes this movement more rapidly than any other projector now in practical use. The nature of the movement is such as to keep wear and tear on the film reduced to a minimum. The mechanical parts which control the movement are of greater durability than those used in any other projector. These great advantages, which are to be had only with Power's Cameragraph, have done their full share in placing this projector in its present preeminent position as the leader in the art of picture projection.

TECHNICAL DESCRIPTION OF THE INTERMITTENT MOVEMENT

The term "intermittent movement" is used to designate that part of the mechanism of a moving picture projector, which performs the important function of stopping the film at regular intervals, so that the photographic views may be successively held in line with the lens.

In Power's Cameragraph this movement consists primarily of four elements, namely: a diamond shaped cam, a locking ring, a pin cross and a sprocket. Photographic views of these parts will be found on page 18.

The cam and locking ring are formed together on the face of a solid steel disc. The four pins of the pin cross are formed from the end of a solid cylinder of steel. The remainder of this cylinder is turned down to the proper diameter to act as a spindle upon which the sprocket is securely fastened. The sprocket has two

rows of teeth to mesh with the holes that are perforated on each side of the film.

Figures *a*, *b*, *c*, and *d*, show these elements in action. A portion of the back of the cam-ring disc has been cut away so as to expose the workings of the movement during one revolution of the disc. The curved arrows

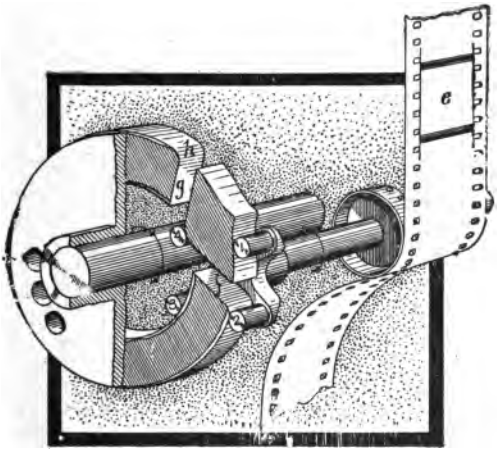


Figure *b*

indicate the direction in which the parts are revolving. The sprocket is in mesh with a short strip of film. Portion *e* of this film, which lies between the heavy black cross lines, represents one of the photographic views to be projected upon the screen.

In Figure *a*, the four pins of the pin cross are shown in engagement with the locking ring. Pins 1 and 2 are at the outer circumference and pins 3 and 4 are at the inner circumference of the ring. Although the ring is

revolving, it cannot impart motion to the pin cross as the pins are securely locked by contact with the inner and outer surfaces of the ring; consequently the pin cross, the sprocket and the film are at rest. It is during this period of rest that the photographic view is being projected on the screen.

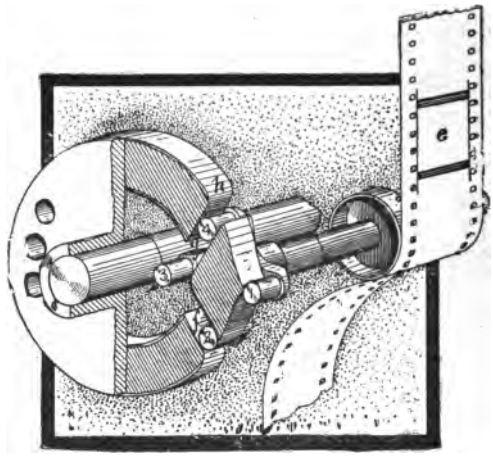


Figure *c*

In Figure *b*, the pins are disengaging from the locking ring. The cam is just starting to engage with pin 1. As the engagement takes place the pin is pushed forward and upward, thus imparting a rotary motion to the pin cross spindle. The sprocket, being fastened to this spindle rotates with it, thus pulling the film downward.

In Figure *c*, pin 1 has almost reached the apex of the cam. Pin 2 is traveling into slot *f*, pin 3 is describing

an arc in the space between the ends of the locking ring, and pin 4 is traveling out of slot *g*. As pin 1 slides over the apex of the cam, pin 4 engages with the curved surface *h* at the end of the locking ring, and the pin is thrown forward and upward until it slides on to the outer surface of the locking ring.

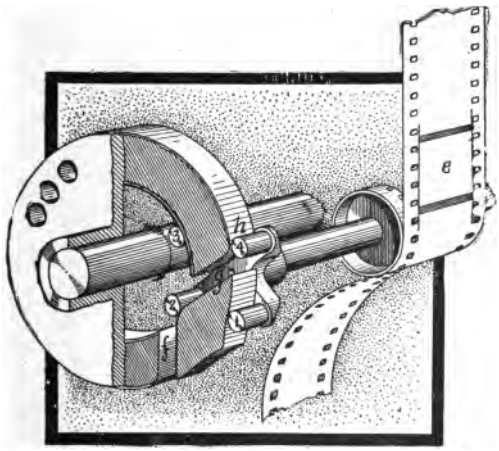


Figure *d*

In Figure *d*, pin 4 has just reached the outer surface of the ring. The four pins are immediately locked as the locking ring travels into the space between them. In contrast to the pin position in Figure *a*, pins 1 and 4 are now at the outer circumference and pins 2 and 3 are at the inner circumference of the locking ring. It can readily be seen that the pin cross spindle has made a quarter revolution, and that view *e*, has been drawn downward a corresponding distance.

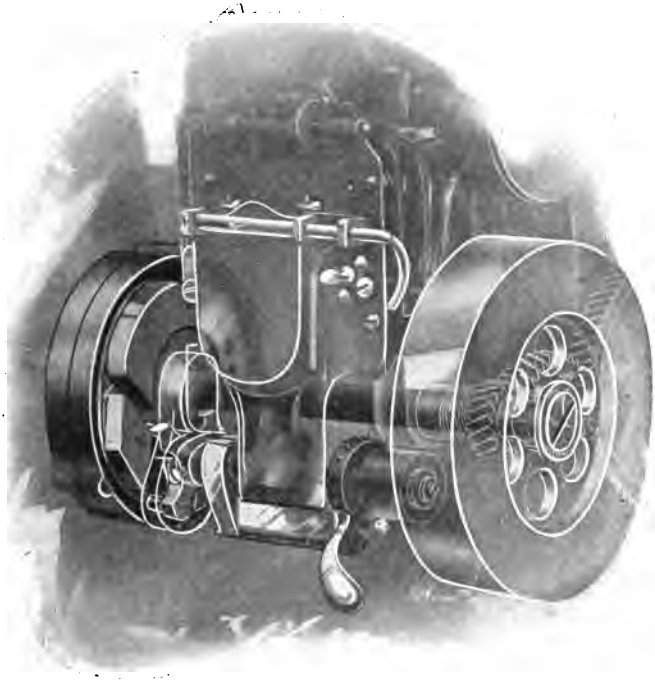
Bear in mind that these pins can only move in the path of a circle. As pins 2 and 4 travel through their respective slots it would appear to the uninitiated mind as though the pins must travel in a straight line. This is not the case however. The fact that the cam-ring disc is revolving, constantly changes the position of

these slots so that their straight lines intersect the circular path of the pins at successively different points.

One great advantage that this particular movement has to offer, may be demonstrated by making the following simple experiment:

Tie a one foot length of ordinary cotton thread to a piece of metal weighing slightly over one pound. Take the untied end of the thread between the fingers and by an upward pull, endeavor to lift the piece of metal a distance of one foot in the shortest possible time. A

sudden jerk will snap the thread. A slow upward pull will allow the thread to stand the strain of the weight, but considerable time is consumed in lifting the metal.



Intermittent movement with oil tight casing

If the slow pull is exerted until the metal has started to move, the pull may then be steadily increased, and consequently the metal can be lifted much more quickly.

This analogy may be applied to the intermittent movement of Power's Cameragraph, which has been carefully designed, to move the film downward, by starting the motion with a scarcely perceptible pull that steadily increases to a maximum as pin 1, (Figure *c*) slides over the apex of the cam, after which it decreases in the same steady manner until the pins are locked by the ring, and the film is again at rest. Not a moment of time is lost, and yet the film is moved so easily that the wear and tear is reduced to a minimum.

The elements of the intermittent movement are made from carefully selected tungsten-chromium steel, which is very tough and durable. The most delicate instruments are used in measuring the dimensions of the elements, one ten-thousandth of an inch plus or minus being the limit of permissible variation.

The cam and pin cross are enclosed in an oil-tight casing. An oil cup is fastened to this casing, and by keeping the parts plentifully supplied with a high grade machine oil, a practically noiseless operation of the movement without perceptible wear on the parts, is insured.

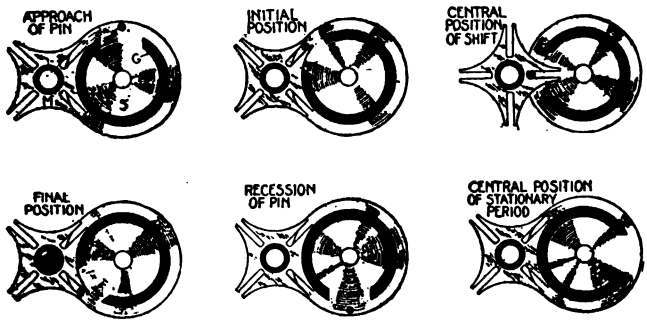
This movement has been used exclusively in Power's Cameragraph for over nine years. It has withstood every test of time, until today it is recognized in the motion picture industry as representing durability, serviceability and dependability.

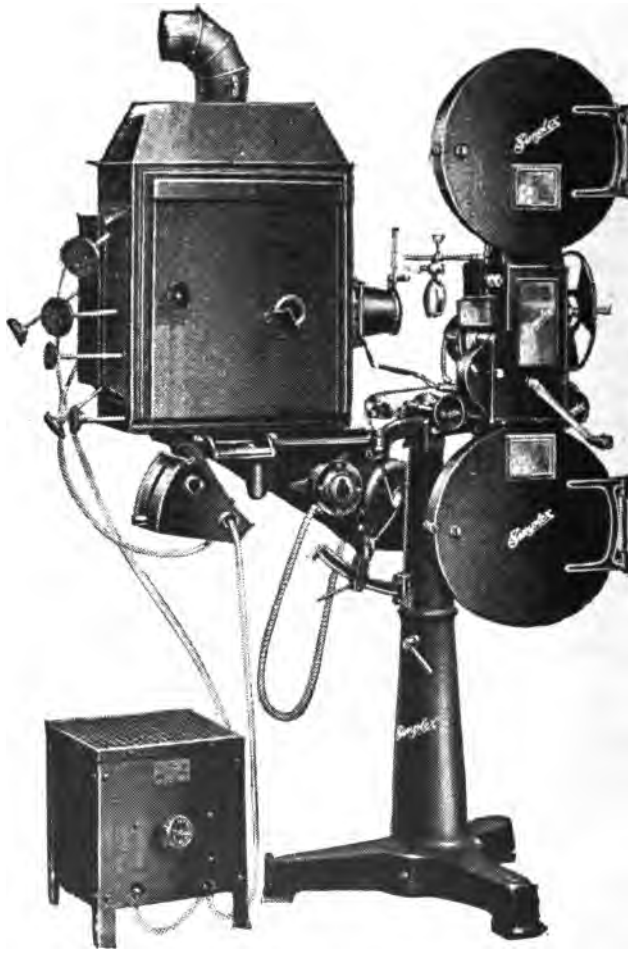
THE GENEVA INTERMITTENT

Diagram showing progressively the operation of the Geneva intermittent movement: Figure 1 shows the approach of pin; Figure 2, initial position or beginning of movement; Figure 3, mid-position; Figure 4, final position or end of the movement; Figure 5, recession of pin; Figure 6, mid-position of stationary period.

The Geneva movement consists of a maltese cross *M*, and a disc *S*, provided with a pin *F*, and a circular guide G.

In operation the pin disc *S* is in continuous motion and the pin is so located that it enters one slot of the cross *M* and carries it along with it, thus causing one-quarter revolution. The circular guide *G* is cut away sufficiently to allow the cross to make a quarter revolution, but when it registers with the cross it holds the latter securely until the pin rotates around to the next slot.

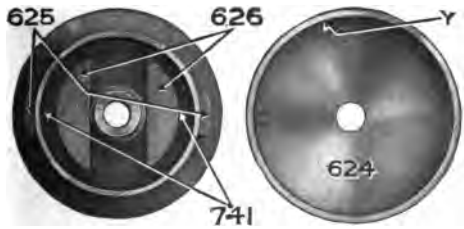




Simplex Projector

AUTOMATIC SHUTTER

The shutter covering the aperture in gate of machine and controlled by the centrifugal movement. It is so arranged that the shutter will be held up by centrifugal force as long as the machine is in motion, but should the machine stop for any reason then the shutter falls and cuts off the light from film. It is a fire prevention device. Should the automatic shutter refuse to work and same cannot be remedied by oiling, it will then be necessary to take the cover off the centrifugal movement Figure 624, then examine springs and shoes Figure 741, and see if the shoe track *Y* is not scratched.



Instructor in motion picture projection explaining to class the use of voltmeter and ammeter in measuring electrical current

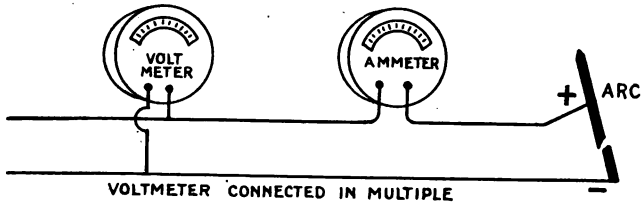
ELECTRICITY

No one knows exactly what electricity is, we do not even know what it consists of, we do know that electricity and magnetism are one and the same. Electricity is not matter nor yet is it energy, although it is a means of transmitting energy, and we know how to handle this force for this purpose.

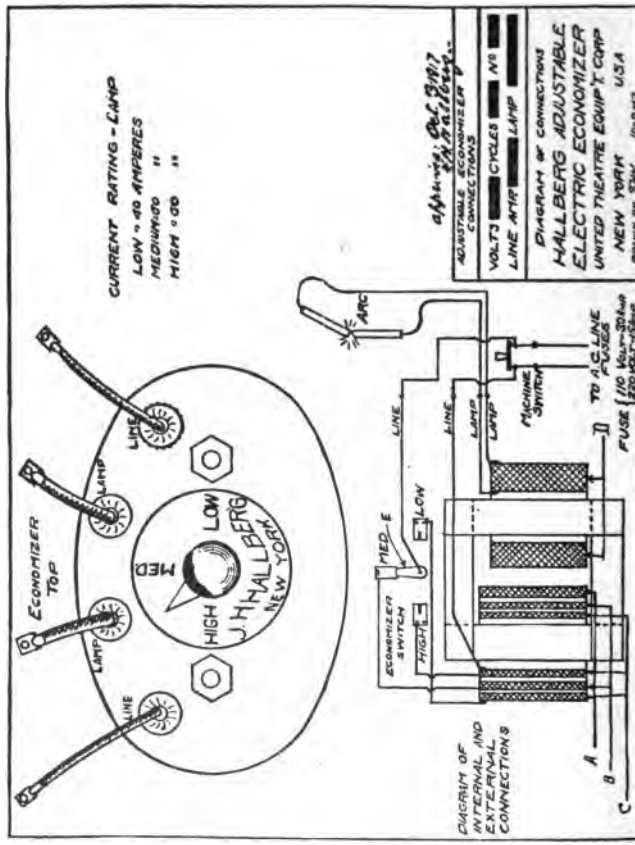
It is an undeniable fact that energy cannot be created nor can it be destroyed, but we can convert one kind of energy into energy of another kind. For example, should we light a fire under a vessel containing water we will convert the heat energy from the coals to steam energy in the vessel containing the water, and we could again change this steam energy into mechanical energy, as is done with the locomotive.

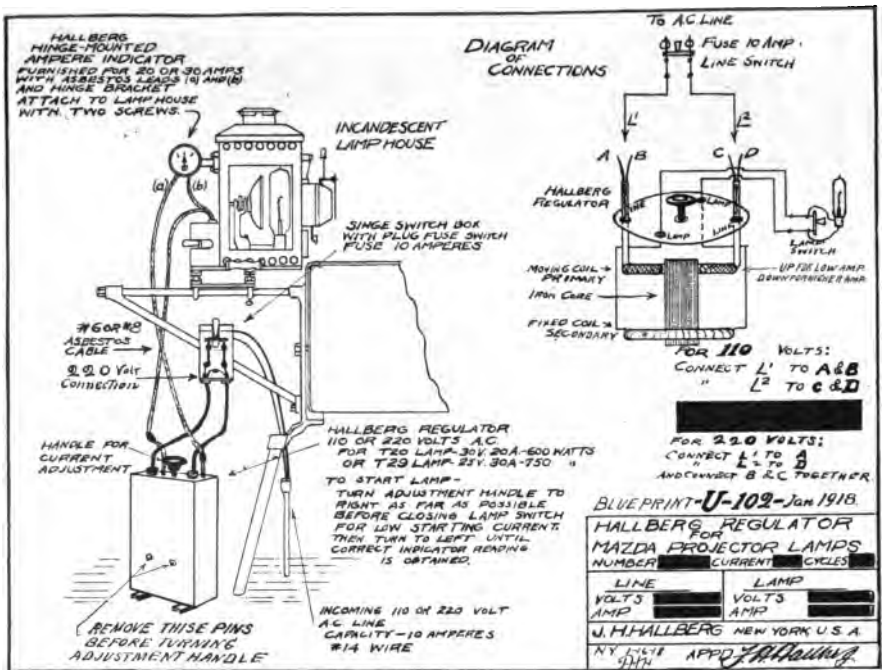
It is also possible to convert mechanical energy into electrical energy so by connecting the mechanical energy created by the steam to a dynamo we would produce electrical energy.

It is also possible to convert electrical energy into mechanical energy. A motor is used for this purpose.



VOLTMETER CONNECTED IN MULTIPLE
AMMETER CONNECTED IN SERIES


CURRENT RATING - LAMP
LOW = 40 AMPERES
MEDIUM 60 "
HIGH = 80 "
ECONOMIZER TOP
LAMP
LINE
LOW
MED
HIGH
J.H.HALLBERG
NEW YORK
ARC
ECONOMIZER SWITCH
MED-E
LOW-E
HIGH-E
LINE
LAMP
MACHINE SWITCH
TO A.C. LINE FUSES
FUSE
A
B
C
DIAGRAM OF INTERNAL AND EXTERNAL CONNECTIONS
ADJUSTABLE ECONOMIZER CONNECTIONS
VOLTS
CYCLES
PH
LINE AMP
LAMP
DIAGRAM OF CONNECTIONS
HALLBERG ADJUSTABLE
ELECTRIC ECONOMIZER
UNITED THEATRE EQUIP'T CORP
NEW YORK
U.S.A


HALLBERG HINGE-MOUNTED AMPERE INDICATOR FURNISHED FOR 20 OR 30 AMPS WITH ASBESTOS LEADS (a) AMP (b) AND HINGE BRACKET ATTACH TO LAMP HOUSE WITH TWO SCREWS.
INCANDESCENT LAMP HOUSE
SINGE SWITCH BOX WITH PLUG FUSE SWITCH FUSE 10 AMPERES
#6 OR #8 ASBESTOS CABLE
220 Volt Connection
HANDLE FOR CURRENT ADJUSTMENT
HALLBERG REGULATOR 110 OR 220 VOLTS A.C. FOR T20 LAMP-30V. 20A-600 WATTS OR T29 LAMP-22V. 30A-750 "
TO START LAMP- TURN ADJUSTMENT HANDLE TO RIGHT AS FAR AS POSSIBLE BEFORE CLOSING LAMP SWITCH FOR LOW STARTING CURRENT. THEN TURN TO LEFT UNTIL CORRECT INDICATOR READING IS OBTAINED.
INCOMING 110 OR 220 VOLT A.C. LINE CAPACITY-10 AMPERES #14 WIRE
REMOVE THESE PINS BEFORE TURNING ADJUSTMENT HANDLE
DIAGRAM OF CONNECTIONS
TO A.C. LINE
FUSE 10 AMP. LINE SWITCH
L1
L2
A B C D
HALLBERG REGULATOR
LINE
LAMP
LAMP SWITCH
MOVING COIL PRIMARY
IRON CORE
FIXED COIL SECONDARY
UP FOR LOW AMP. DOWN FOR HIGH AMP.
FOR 110 VOLTS: CONNECT L1 TO A & B
" L2 TO C & D
FOR 220 VOLTS: CONNECT L1 TO A
" L2 TO D
AND CONNECT B & C TOGETHER
BLUEPRINT-U-102-Jan 1918.
HALLBERG REGULATOR FOR MAZDA PROJECTOR LAMPS
NUMBER [redacted] CURRENT [redacted] CYCLES [redacted]
LINE VOLTS [redacted] AMP [redacted]
LAMP VOLTS [redacted] AMP [redacted]
J. H. HALLBERG NEW YORK U.S.A.
NY 1-418 9-14 APPD J.H.Hallberg.

The word dynamo is used to designate a machine which produces direct current as distinguished from the alternator or generator which produces alternating current. A dynamo does not create electricity but produces an induced electric-motive force which causes a current of electricity to flow through a circuit of conductors in much the same manner as a pump causes water to flow through a pipe. The point to be settled in the minds of those taking up electricity is that the dynamo merely sets into motion something already existing, by generating sufficient pressure to overcome the resistance to its movement.

Although we speak of alternating and direct current, it should be clearly understood that it is impossible to get a continuous current with a dynamo. The current is really a pulsating one, but the pulsations are so small and follow each other so quickly that the current is practically continuous.

Resistance. The property of anything in an electric circuit which will resist the flow of current. Can be compared to the resistance offered to the flow of water through a pipe, by the friction created by the sides of the pipe. The effect of resistance is to produce heat. Everything in the circuit offers resistance. The resistance of all wires increases as the diameter of the wire is made less, or as its length is increased. The resistance decreases if the wire is made larger (cross section) or is decreased in length.

The resistance of all metals increases with an increase of temperature.

The resistance of all carbons and insulating material decreases with an increase of temperature.

Resistance consumes pressure.

To find the resistance offered by a copper wire, multiply its length in feet by 10.5 and divide the product by the area of wire in circular mils.

Ohms Law. Ohms law is merely the fundamental principal on which most of electrical mathematics are worked.

A series of formulas used by electricians in figuring voltage, amperage and resistance:

FORMULA 1. To find the amount of current flowing in a circuit divide the voltage by the resistance, or

$$\text{Current} = \frac{\text{Electric Motive Force}}{\text{Resistance}}$$

For instance, if we have a line voltage of 100 and our circuit has a resistance of 5 ohms, then by dividing 100 by 5, we would get our amperage.

$$5 \overline{)\,100\,(\,20}$$
$$\underline{100}$$

so we would have 20 amperes.

FORMULA 2. To find the amount of resistance in a circuit, divide the voltage by the amount of amperage drawn, or

$$\text{Resistance} = \frac{\text{Electric Motive Force}}{\text{Current}}$$

For instance suppose we have a line voltage of 100 and are using 20 amperes at arc lamp, then by dividing the 100 by 20 we would get the amount of resistance we have in our circuit.

$$20 \overline{)\,100\,(\,5}$$
$$\underline{100}$$

so we would have 5 ohms resistance in our circuit.

FORMULA 3. To find the voltage of a circuit, multiply the amount of amperes drawn by the amount of resistance, or

Electric Motive Force = Amperes times Resistance

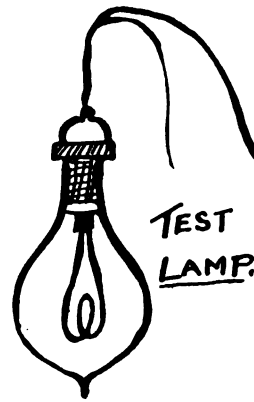
For example: If we had 20 amperes at arc and our circuit was offering 5 ohms resistance, then by multiplying 20 by 5 we would get our voltage.

20 amperes
5 ohms

100 volts

To find Volts. Multiply number of Amperes by amount of Resistance.
To find Resistance. Divide Voltage by Amperage.
To find Amperage. Divide Voltage by Resistance.

To find Watts. Multiply Voltage by Amperage.
To find Amps. Divide Watts by Volts.
To find Volts. Divide Watts by Amperage.



DYNAMOS

A dynamo electric machine is a device for converting mechanical energy into electric energy. The word dynamo is generally understood to mean a machine for converting mechanical energy into electrical energy, and the word motor means a machine for converting electric energy into mechanical energy, the essential parts of a dynamo and motor are the same, namely—the armature and field magnet.

Dynamos are divided into two general classes, according to the character of the current they deliver. A direct current dynamo delivering a current that always flows in the one direction, that is, the current never reverses, though it may change in value or pulsate.

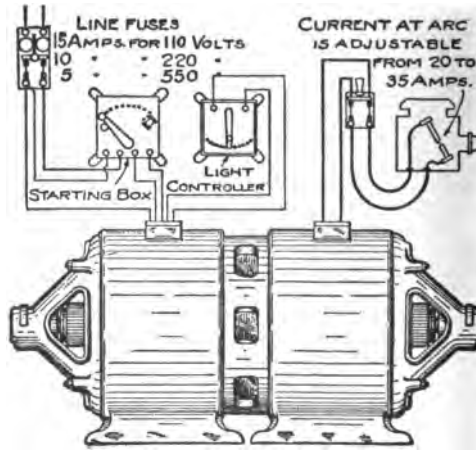
100 K.W. ENGINE-TYPE GENERATOR AND AUTOMATIC HIGH-SPEED ENGINE.

Alternating current dynamos or alternators, deliver a current that periodically reverses its direction of flow, the number of reversals per second depending on the number of poles in the dynamo and on the speed of rotation.

A direct current dynamo usually consists of a series of conductors arranged on the surface of a cylindrical iron core or in slots near the surface, the conductors in most cases being parallel with the axis of the core.

The core is mounted on a shaft that is supported on bearings so that the armature can be rotated near the pole faces of a field magnet. This magnet is excited by one or more field coils. Any even number of poles may be used according to the size and type of machine.

The principal parts of a dynamo are: armature core, bands on armature core, commutator, shaft, field coils, pole faces, brushes, rear end bearing, front end bearing, rear end journal, front end journal, terminal block and bedplate.



THE RHEOSTAT

The rheostat is an instrument or device introduced into your circuit to offer resistance and thereby reduce the line voltage.

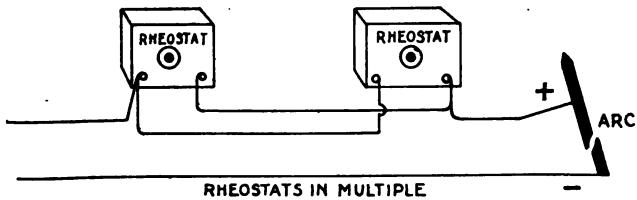
A rheostat is made of a number of metal coils or plates connected in series and mounted on an insulated frame, and covered with a perforated metal cover.

Rheostats may be connected in series or multiple with each other but must always be connected in series with the arc.

Rheostats are sometimes spoken of as resistance boxes, they can be used on either alternating or direct current, although it is more economical to use a transformer on alternating current instead.

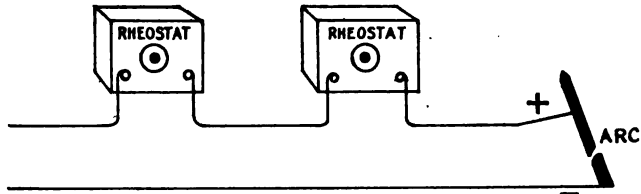
The same rheostat will pass about 10% more amperage on A. C. than on D. C., the reason being that with an A. C. arc you must feed the carbons a little closer together and this will draw more amperage.

By connecting two rheostats in series their total resistance will be added. For instance if we connected two rheostats each offering 4 ohms resistance, in series



with each other we would then have a total resistance of 8 ohms on our line. By connecting the same two rheostats in multiple with each other we would only have approximately 2 ohms resistance in our line.

Never connect 110 volt rheostats either singly or in multiple on a 220 volt circuit because by so doing you will burn out the coils. However it is possible to use two 110 volt rheostats connected in series with each



RHEOSTATS IN SERIES

other on 220 volts although they would be a trifle overloaded and should only be used till such time as a 220 volt rheostat can be obtained.

The point must never be lost sight of that rheostats are very wasteful, the electrical energy is converted into heat energy which goes to waste, but which is of course registered on the meter and has to be paid for.

Rheostats are considerably less than 50% efficient.

All connections in a rheostat should be kept tight and the lugs and leads attached to the binding posts of rheostats should be removed every so often as it will be found that both the leads and lugs have lost their nature through the excessive heat. This also applies to the lugs and asbestos leads in the arc lamp.

Should a coil burn out while you are operating, the rheostat can be patched up for the time being, by dis-

connecting the short length of the coil and stretching the other part of broken coil till same can be screwed in place.

Rheostats should always be placed outside the booth, it will reduce the fire risk, and it will be a lot more comfortable for the operator.

Power's rheostat with cover removed showing connection of coils

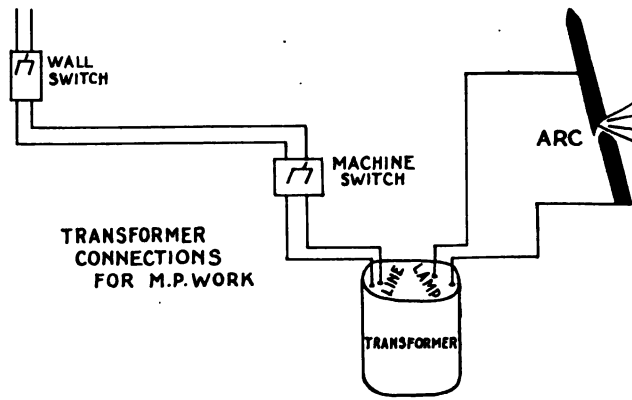
THE TRANSFORMER

The transformer is an apparatus used on alternating current in place of a rheostat.

A transformer is made of two copper coils the primary and secondary and a laminated iron core. The current enters through the primary coil and the action of the current (A. C.) sets up in the transformer a magnetic field around the iron core, the secondary coil cuts the lines of magnetic force and carries off the new magnetized current to the arc lamp.

The current gets from the primary to the secondary coil by induction, there is no metallic connection between the two, in fact the coils are insulated from each other and from the iron core.

There are two kinds of transformers: step-up transformers and step-down transformers. The step-up



transformers steps up the voltage and lowers the amperage. The step-down transformer steps down the voltage and raises the amperage. It is always the step-down that is used in connection with motion picture work.

The wattage on the primary coil is always larger than on the secondary coil, that is, the input is greater than the output in watts. This is due to the losses in transforming the current. The losses are divided into two classes:

(*a*) The iron or core losses.
(*b*) The copper losses.

The core losses are going on as long as the switch on the line side of transformer is closed, in other words while the transformer is carrying a no-load current.

The copper losses take place only while the arc is burning or current is being drawn from the secondary coil.

An auto-transformer is a transformer with one coil only, part of the coil being traversed by the primary circuit and part by the secondary circuit.

Mica is the most efficient insulation for transformers.

Transformers are known under many trade names such as economizers, inductors, etc.

By installing a transformer in place of a rheostat on a 110 volt alternating current system the makers claim there is a saving of about 66%.

Transformers are about 95% efficient.

CARBONS

Carbons are made in different lengths and different sizes in cross section, it is necessary that you use the proper combination of carbons to secure best results on screen. On 110 volts D. C. up to 35 amperes use 5-8 cored in top (positive) and 1-2 solid in bottom (negative), from 35 to 60 amperes use 3-4 cored in top (positive) and 5-8 solid in bottom (negative) from 60 to 80 amperes use 7-8 cored in top and 5-8 solid in bottom.

On A. C. using up to 35 amperes at arc use 5-8 cored for top and bottom, from 35 to 60 amperes 3-4 cored top and bottom, from 60 up to 80 amperes use 7-8 top and bottom.

The resistance of carbons decreases with an increase of temperature.

Store your carbons in a dry place.

See that carbons make good contact in jaws of arc lamp.

THREE WIRE SYSTEM

A system of wiring where three instead of two sets of two wires are used, generally obtained by connecting two dynamos in series and connecting a third or neutral wire to a point common to both dynamos. The wires are positive, negative and neutral. The advantage of the system is the saving of copper. The disadvantages of the system (aside from the question of generation) are that the switches, etc., are more expensive, and unless the system is kept balanced (the same amount of amperage being drawn off both sides of the system) you are liable to damage the lamps on the line.

In the three wire system two dynamos alike in voltage and capacity are connected in series between the outside wires, and the neutral wire is connected with a point in the circuit between the two dynamos.

Being in series the voltage of the dynamos are added making the voltage between the two outside wires double that between the neutral (middle wire) and either of the outside.

The lamps are connected between either of the outside wires and the neutral wire, and if an equal number of lamps are connected on each side (that is, if the

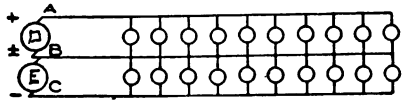


Fig. 1

system is balanced) there will be no flow of current in the neutral wire.

In any case, the amperage in the neutral wire is the difference between the amperage drawn from each side. This difference should be kept as small as possible.

Figure 1 shows a three wire system. *D* and *E* being two 110 volt dynamos connected in series, *A* is the positive wire, *B* the neutral wire, and *C* the negative

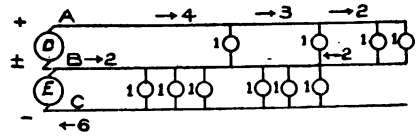


Fig. 2

wire. The ten circles on either side of the neutral wire represent lamps each taking one ampere, as we have the same amount of current (10 amperes) being drawn off either side, the system is balanced and there is no flow of current in the neutral wire. The ten amperes being drawn from the positive wire *A*, and returning to the dynamo over the negative wire *C*.

Figure 2 shows an unbalanced three wire system. Taking it for granted that each of the lamps is taking one ampere, then we have four amperes on one side and six amperes on the other, so our system is unbalanced to the extent of two amperes, which represents the flow of current in the neutral wire. Connected between wires *A* and *C* we would have 220 volts, or the added voltage of the dynamos. Connected between *A* and *B* or between *B* and *C* we would have 110 volts.

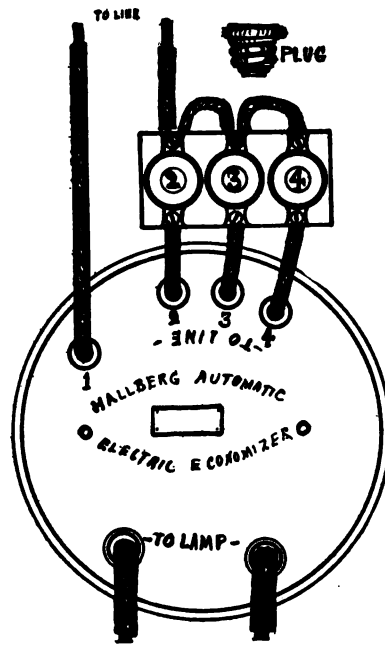
THE HALLBERG ECONOMIZER

The Hallberg economizer is simply a transformer of the semi-constant current type, taking A. C. current at line voltage and delivering A. C. current at arc voltage. Semi-constant means that it will take the line current at a fixed potential and will deliver from the secondary a steady amperage flow regardless of the length of the arc.

The economizer consists of a continuous rectangular core, on one leg of which is the primary winding, on the opposite core leg is the secondary which is made of larger cross section wire, this coil is connected to lamp.

On 110 volts the economizer line wires are usually attached to terminals *1* and *2* for any voltage from 100 to 105, to *1* and *3* for 110 volts or to *1* and *4* for voltage between 115 and 210. See diagram on page 48.

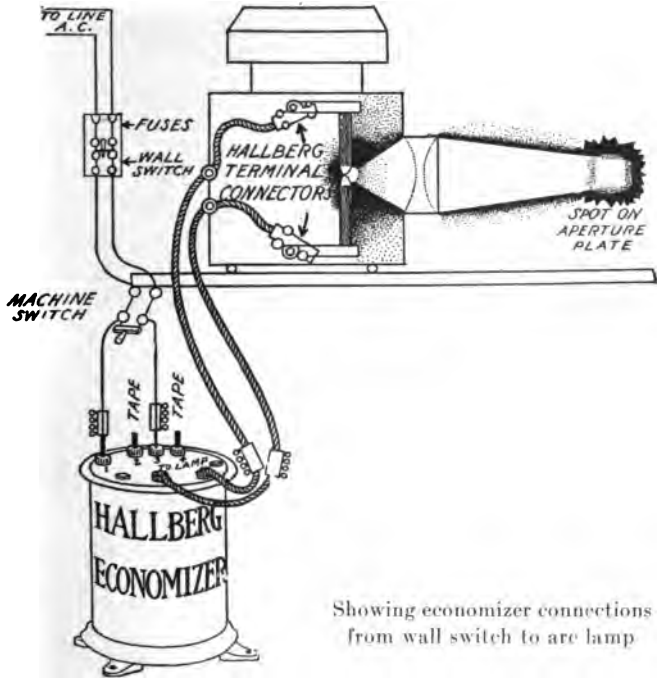
Some operators desire varying candle power at the arc lamp to accommodate lighter or more dense films, in a case of this kind, it is possible to simply install a three pole main line cut out (with one single fuse plug) connected to the economizer (see diagram). By placing the plug in socket No. *2*, a heavy amperage is obtained, Unscrew plug and place in *3* and we get a medium current, and if we place plug in *4* we get the lowest amperage possible. This gives us three degrees of amperage at arc. By installing more than one fuse at a time we would blow the fuse as this would be short-circuiting the primary coil.



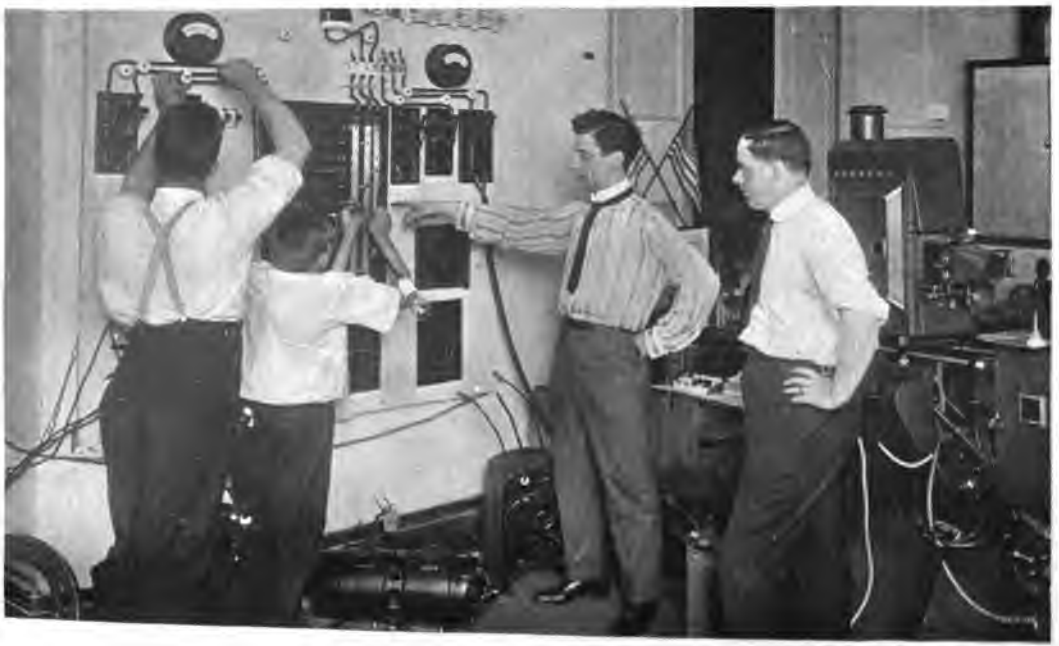
When using the Hallberg economizer:

1. Place economizer at least 12 inches away from sheet iron walls, as otherwise there will be a humming noise.
2. 30 amperes line fuses is large enough for 110 volts and 15 amperes for 220 volts.
3. Connect fuses, switches and wires exactly as illustrated on page 49.
4. Make sure that all connections are tight, especially at the carbon clamps in the lamp house.

5. Cover all line terminals on economizer with tape.
6. Use only 5-8 inch soft carbons cored.
7. Feed carbons often and a little at a time.
8. Keep arc short, not over 1-32 inch.



Showing economizer connections from wall switch to arc lamp



Installing electric wiring system at Red Cross Institute

CONVERTERS

A converter is any piece of apparatus for changing electrical energy from one form to another.

A direct current converter converts from D. C. to D. C.

A rotary converter converts from an alternating current to a direct current.

A rotary converter combines a motor and generator having but one field and one armature winding.

EQUIVALENTS OF ELECTRICAL UNITS

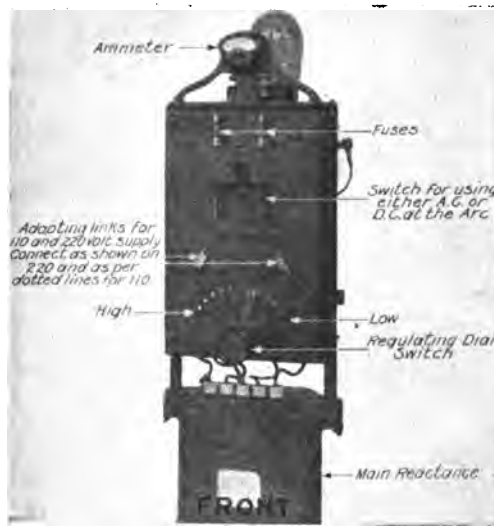
1 kilowatt = 1000 watts

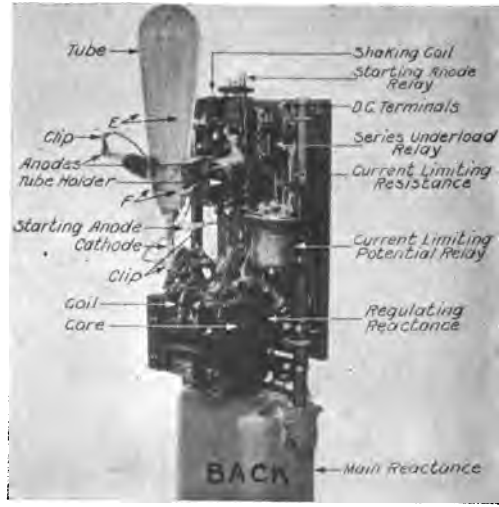
1 kilowatt = 1.34 H. P.

1 kilowatt = 44,257 foot pounds per minute

1 horse power = 746 watts

1 horse power = 33,000 foot pounds per minute





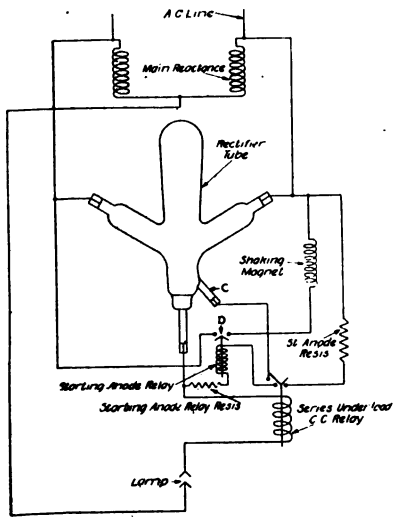
Front and back view of mercury rectifiers

MERCURY ARC RECTIFIERS

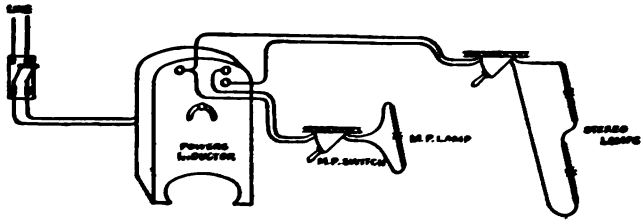
An apparatus used to change A. C. to D. C.

Consists of a glass bulb into which are sealed two iron anodes and one mercury cathode and a small starting electrode.

The bulb is filled with mercury vapor. No current will flow till the starting electrode resistance has been overcome by the conization of the vapor in its neighborhood. To accomplish this, the voltage is raised sufficiently to cause the current to jump the gap between the mercury cathode and the starting cathode, or by bringing the cathode and starting electrode together in the vapor by tilting and then separating them, thus drawing out the arc. When this has been done current will flow from the anode to the mercury cathode and not in the reverse direction. In order to maintain the action a lag is produced in each half wave by the use of a reactive or sustaining coil, hence the current never reaches its zero value otherwise the arc would have to be re-started.



medium and 65 on high. The efficiency rating of the Powers inductor will compare favorably with any transformer on the market. It weighs approximately 100 pounds, occupies a floor space of 12 x 14 inches and is 19 inches in height. Below we see a Powers inductor connected to two arc lamps.



Powers inductor connected to two arc lamps

CARE OF MOTOR

The motor must be kept clean, if the commutator becomes rough, smooth it up with No. 00 sandpaper moistened with a little oil. When fitting new brushes always sandpaper them down to fit the commutator perfectly by passing to and fro beneath the brushes a strip of sandpaper having the rough side of paper towards the brushes.

Always renew brushes before they get too short, as should the brush holders come in contact with commutator great damage may be done.

Keep the grease cups well filled. If the motor gets overheated, see that bearings are all right; see that motor is lined up true.

It is well to test motor every now and again with a speed indicator to see that you are getting the rated number of revolutions per minute. Trouble in a motor may thus sometimes be avoided.

Sparking at commutator may be laid to several faults, among them being: dirt, uneven brushes, high mica, broken segment in commutator.

MEASURING WIRE

First scrape off the insulation, then take one strand of wire and insert it in the smallest slot possible on a Brown and Sharp wire gauge. Find out (by using wire table) the number of circular mils contained in the one strand, then multiply the number of circular mils by the number of strands in the wire, then refer to wire table and find the nearest corresponding number of circular mils, look opposite to find what size wire you have.

For instance, suppose we are going to measure a length of stranded wire, we first take one strand and measure with B. & S. gauge. Let us take it for granted that it measures No. 14, now find out by using table on page 58 how many circular mils there are in a No. 14 wire—4,107; next count the strands in the wire and say we count 7; then, by multiplying the 4,107 by 7 we will find the circular mils in the whole wire or $4,107 \times 7 = 28,749$ circular mils in the whole wire. Now find the nearest corresponding number to 28,749 in circular mil table and we find it is 26,250, and looking over to the first column we find this to be a No. 6 wire.

CARRYING CAPACITY OF COPPER WIRE

B. & S. Gauge	*Circular Mils*	*Table A Rubber Insulation Ampere*	*Table B Other Insulations Ampere*
18	1,624	3	5
16	2,583	6	8
14	4,107	15	16
12	6,530	17	23
10	10,380	24	32
8	16,510	35	46
6	26,250	50	65
5	33,100	54	77
4	41,740	65	92
3	52,630	76	110
2	66,370	90	131
1	83,690	107	156
0	105,500	127	185
00	133,100	150	200
000	167,800	177	262
0000	211,600	210	312
	200,000	200	300
	300,000	270	400
	400,000	330	500
	500,000	390	590
	600,000	450	680
	700,000	500	760
	800,000	550	840
	900,000	600	920
	1,000,000	650	1,000
	1,100,000	690	1,070
	1,200,000	730	1,150
	1,300,000	770	1,220
	1,400,000	810	1,290
	1,500,000	850	1,360
	1,600,000	890	1,430
	1,700,000	930	1,490
	1,800,000	970	1,550
	1,900,000	1,010	1,610
	2,000,000	1,050	1.670

The lower limit is specified for rubber-covered wires to prevent gradual deterioration of the high insulations by the heat of the wires, but not from fear of igniting the insulation. The question of drop is not taken into consideration in the above tables.

MOTOR GENERATORS

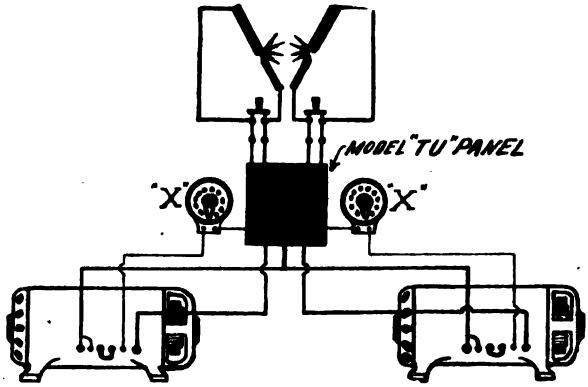
A motor generator is simply a generator or set of generators connected to a motor. For motion picture work the generator is always D. C. and the motor either A. C. or D. C. according to the system it is to be used on.

Motor generators are known under many trade names such as converters, transverters, D. C. economizers.

The Hallberg motor generator is so designed and constructed, that it may be connected to operate singly, or, if two are installed they may be operated in multiple, thus delivering any desired amperage from the lowest to the full capacity of both generators to either arc.

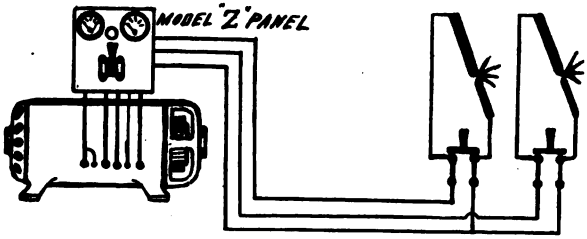
The Hallberg twin unit system gives one separate generator for each arc, when dissolving the picture from one machine into the other, then without the

Hallberg Motor Generator
60 cycles A. C. to D. C.



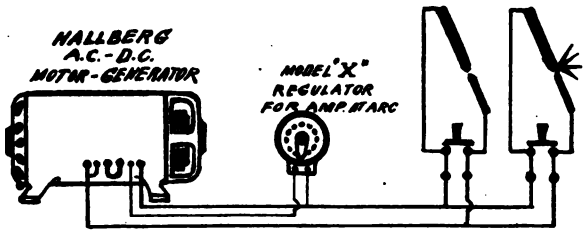
Twin Unit System
Arcs in multiple

least interference the current at the projecting arc may be doubled for perfect screen results with dark films or for long throws. No extra emergency transformer or rheostat is required with the twin unit system as either generator may be used on either projecting arc at a moment's notice.



Double Arc Outfit
Generator wiring for double arc

The arcs (if more than one) with a Hallberg generator are always connected in multiple. This is of great advantage because it is thus possible to deliver the maximum ampere output of the generators to either one of the arcs for very dark films. This would not be possible with generators wound for arcs in series.



Single Arc Outfit
Generator wiring for one arc, or for two arcs, when stealing the arcs

OPERATING BOOTH

The booth should contain everything necessary for perfect projection, but nothing that can be done without. Nothing but the projection of films should be done in the booth, an ante-room should be provided with work bench and rewinder. The booth should be large enough to permit the free movements of the operator or operators and should contain the necessary closets and shelves for the operators' clothes, tools, supplies, etc.

The operator should see that he has sufficient supplies, such as fuses, lugs, film cement, asbestos cable, condensers, various lubricants, carbons, mica, brushes for motor, belting and a few of the necessary parts for machine to replace those parts that are liable to need replacing owing to wear, etc.

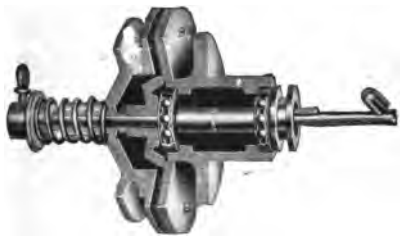
The operator should carry a kit of tools that will permit him to do any repair work that he may be called upon to do, the manager of today has very little use for the would-be operator who shows up on the job with a ten cent pair of pliers and a piece of string.

If using rheostats then same should be installed outside the booth, as should mercury arc rectifiers. The operator will thus find working conditions a whole lot more comfortable.

All openings such as projection holes and port holes should be so equipped with shutters that they will all close automatically in case of fire.

A lot could be said about the position of booth and the construction of same, but the trouble is that the operator is generally the last man a manager or exhibitor will consult in this matter when planning the theatre, so the operator has to work under conditions as he finds them.

One thing we would advise and that is, that the walls of the booth should be painted black (if same has not been done). The size of all openings should be reduced as much as possible, shade all lights so that none of the light finds its way into the auditorium of theatre.



Showing the take-up mechanism
of Powers machine

FILM

The film used for motion picture work is similar to that used in ordinary photographic work, only it generally comes to the operator in lengths of approximately 1,000 feet. The size of each picture on the film is 11-16 by 15-16. The margin of the film is perforated (four holes to the picture). These holes engage on the teeth of the sprockets.

Never lose sight of the fact that the film is highly inflammable and should at all times be kept in fireproof boxes. Great care should be taken when threading the machine with the film, to see that it does not come in contact with the hot lamp house. All film should be examined before showing. While this is no part of an operator's duties, it will work to his advantage in the long run.

Under no conditions let your film run on to the floor of the booth. Should the take-up refuse to act or should the film break, stop the machine and fix it.

There are a number of ways of cleaning film, a number of machines being on the market for this purpose, but we hold that the cleaning of film should be done in the film exchange and not by the operator; an operator is paid for projecting the pictures and should be able to give his undivided attention to this.

Operators when using first run film will find that the emulsion will come off film and adhere to the tension bars and film runners in gate of machine. A very, very

little paraffin or vaseline on tension bars will help to overcome this. After running a new film be sure to scrape off any emulsion that may be on the machine, using a piece of soft metal, a copper penny will be found suitable for this purpose. Failure to do this may mean the breaking of the next film you put through the machine as this emulsion will cause unnecessary tension.

Film Cement. Should you run out of cement at any time you can tide yourself over with a bottle of "New Skin," or you can make your own cement as follows:

Equal parts of amyl acetate and acetone, or

1 oz. collodion (New Skin)
1 oz. banana oil
½ oz. ether, or

8 ozs. of acetone, 1 oz. ether, into which dissolve a few inches of film.

WIRING

Conduit system must be installed first, with conductors; metal ends must be bushed, and the metal of the conduit must be permanently grounded. For alternating current systems, you must have the two or more wires drawn through the same conduit. It is advised that this be done on direct current systems also, in case same is ever turned into an A. C. system. The same conduit must never contain circuits of different systems but may contain two or more of circuits of the same system.

Rubber-covered wires should have in addition to the rubber covering placed next to the conductor itself, an outer protective covering of cotton braid.

The neutral wire on a three wire system may be grounded and when grounded the following rules must be complied with: Must be grounded at the central station on a metal plate buried in coke beneath permanent moisture level and also through all available underground water systems. In overhead systems the neutral wire must be grounded every 500 feet.

Flexible armored cable. Twin conductors

TESTING FOR GROUNDS

Always remember that like poles repel each other while unlike poles attract each other, in other words the negative polarity is attracted by the positive polarity, and vice versa, while the negative has no attraction for negative nor the positive for positive.

The positive wire of one system will have no attraction for the negative wire of any other system except its own, nor will the negative of one system find any attraction in the positive of any other system.

A ground is merely the current from one polarity being attracted by the opposite polarity, through the ground or some conducting medium other than that in the circuit.

In a three wire system the neutral wire is always grounded.

Now supposing that we are working on a three wire system and our neutral wire is grounded, and that we take and connect one of the outside wires to the upper jaw of arc lamp, and we connect the neutral wire to the lower jaw (the neutral wire now acts as negative to the upper or positive wire). We now ground the machine by connecting the metal framework of machine to the conduit coming in booth. Our machine now becomes grounded on the neutral because we have made contact between the frame of machine and the already grounded conduit. Should we now connect our test lamp between the upper jaw of arc lamp and frame of

Arc lamp with carbons fixed in position
showing the various adjustments

machine or lamp house we will naturally get a light as we are connected between the two polarities of the system.

Now should the arc lamp become grounded (caused we will say by the mica insulation coming out of jaw connection) on the lower jaw it would mean that the system is grounded on the negative polarity and the arc itself is grounded on the negative polarity, and this may or may not blow the fuse. But should it be the upper jaw of lamp that becomes grounded then our arc would be grounded on the opposite polarity to that of the machine, and thus cause a short circuit.

To test for a ground in the lamp house, first disconnect the ground wire and connect the terminals of test lamp between the upper and lower carbons. We should now get a light as we are connected between both polarities, this test merely shows that we have current in our lamp.

Now connect the test lamp between the upper carbon and the frame of lamp house, if we get a light then our lower jaw is grounded, if we do not get light then take it for granted that lower is free from grounds.

Now test to see if the upper is grounded by connecting the test lamp between the lower jaw of arc lamp and the frame of lamp house, if we get a light then upper jaw is grounded. Always find the cause of ground and remove same at earliest opportunity.

Before using the test lamp see that lamp is alright and that it is tight in socket.

To test for a ground in the rheostat, use a bell set. First connect the terminals of bell set between the two binding posts of rheostat, and if rheostat is free from

open circuits you should get a ring, next connect the terminals of bell set between one of the coils or plates in rheostat and the iron frame, if you get a ring it signifies that the rheostat is grounded but this test will not tell you which coil or plate is causing the ground. To find exactly where ground is, proceed as follows: connect bell set between the first coil and frame, if you get a ring, disconnect the first coil, now connect between the second coil and frame, if you get a ring disconnect the second coil, and do the same to third and fourth coil, keep testing in this manner till bell stops ringing, then the coil you removed last was the coil that was grounded, so if you have removed six coils and the bell stops ringing when connected between the seventh coil and frame, it was coil number six that was grounded.

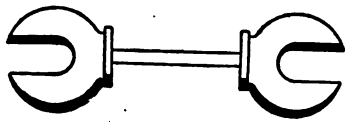
If the rheostat is made of more than one section, test each section separately and find which section the ground is in, then proceed as above. This is to save time.

FUSES

A safety device used on your line to protect the circuit.

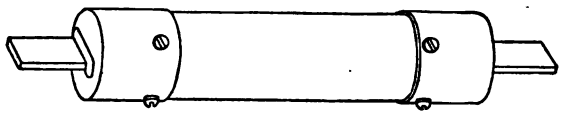
A short length of fusable wire introduced in a circuit so that if the temperature of circuit should rise above the rated capacity of fuse the wire will melt and thereby open the circuit.

Fuses are made in different shapes and sizes, the moving picture operator, however, will only be called upon to handle the under-mentioned.



Copper-tipped fuse link

Link Fuse. The link fuse is the fuse always used in the booth, being of the open type it cannot be readily boosted without same being plainly seen. Link fuses



Enclosed or "cartridge" fuse

Section of enclosed fuse

Powers Cameragraph No. 6A
Showing rheostat and motor connections

have no protective covering so should always be installed in a metal cabinet.

Cartridge Fuse. Made by connecting two metal cap terminals with a short paper tubing. The two metal caps are connected by a thin wire which runs through the paper tubing, the tubing is filled with some non-conducting powder.

Plug Fuses. Plug fuses are used for protecting the house wiring and circuits carrying small amperage.

In fusing upon any circuit you must take into consideration the size of the wire used and the amount of amperage to be drawn. The fuse should be under the carrying capacity of the wire with a sufficient margin to allow the required number of amperes to pass over without overheating. The rating of all fuses is marked on them. Never use a fuse not marked.

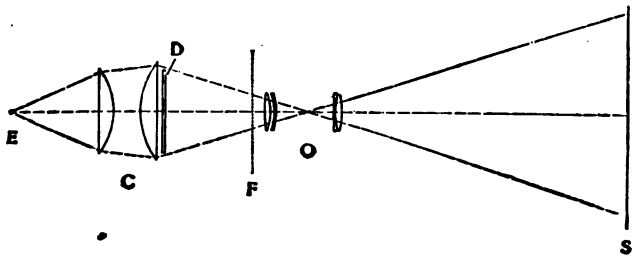
Edison fuse-plug

Powers Cameragraph in operation at Red Cross Institute for Crippled and Disabled Men

PRINCIPALS OF OPTICAL PROJECTION

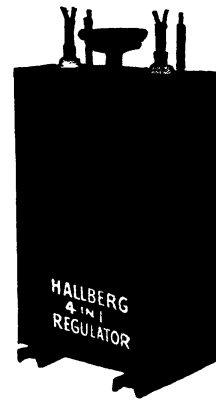
The process is almost the reverse of ordinary photography. For instance in photography a scene by means of the photographic objective or lens is photographed and a reduced image is obtained on ground glass. This glass is replaced by a sensitized plate and by the use of chemicals the image is fixed thereon.

In projection the process is reversed, that is, a transparent slide is made from the picture, or the roll of film taken with the motion picture camera is developed and used in the motion picture machine (the projector). By means of a condensed light they are strongly illuminated and with an objective lens an enlarged image is projected upon the screen, this screen image corresponding to the real objects photographed. The principles of optical projection for motion picture machine will readily be understood from the diagram below.



Showing the optical system of a moving picture circuit and how rays of light travel from arc E to screen S

At *E* is an electric arc or other suitable illuminant, the light from which is caught up by the condenser *C*. This condenser is an arrangement of lenses so constructed as to gather up the greatest volume of light possible and to concentrate the light which it gathers at the center or diaphragm plane of the objective when the objective is located at the proper distance from the film, which distance is determined by the focal length of objective lens.



The film should be placed at such a point that the entire area of the aperture in gate is fully illuminated, and it should also be placed so that the greatest number of light rays possible should pass through it.

Proceeding from the slide *D* or film *F* the light passes through the objective *O* where the rays cross and the object is therefor reversed, by means of the objective, the object is also imaged or delineated upon the screen *S*, the degree of sharpness or flatness of the image depends upon the optical connection of the lens.

Great care should be taken to line up properly the arc, condensers and the objective lens, as under the best of conditions less than 5% of the light from arc reaches the screen.

LENSES

The optical system of a moving picture circuit comprises:

(*a*) The arc lamp or mazda lamp.

(*b*) The condensers.

(*c*) The lens, or objective.

The optical system is a very important one and one that has long been neglected by the majority of operators. A number of men who have been operating machines for years have never taken the lenses apart and have no idea of the different combinations making up the objective lens.

There is no motion picture book published that we know of which goes far enough into this matter, and we would advise anyone desirous of getting all the information possible on lenses to study the books dealing with this subject that may be found in the various libraries.

A list of suitable books may be obtained by writing the Technical Editor of the *Motion Picture News*, New York City.

The following is an outline of what an operator should know, and has been gathered from several books dealing with optical systems and lenses.

Reflection. The change of direction experienced by a ray of light when it strikes a surface and is thrown

back or reflected. Light is reflected according to two laws:

(*a*) The angle of reflection is equal to the angle of incidence.
(*b*) The incident and the reflected rays are both in the same plane which is perpendicular to the reflecting surface.

Refraction. The change of direction which a ray of light undergoes upon entering obliquely a medium of different density from that through which it has been passing. In this case the following laws obtain:

(*a*) Light is refracted whenever it passes obliquely from one medium to another of different optical density.
(*b*) The index of refraction for a given substance is a constant quantity whatever be the angle of incidence.
(*c*) The refracted ray lies in the plane of the incident ray and the normal.
(*d*) Light rays are bent toward the normal when they enter a more refracted medium and from the normal when they enter a less refracted medium.

A lens may be defined as a piece of glass or other transparent substance with one or both sides curved. Both sides may be curved, or one curved and the other flat.

The object of the lens is to change the direction of rays of light and thus magnify objects or otherwise modify vision.

Lenses may be classed as:

Double convex	Double concave
Plano convex	Plano concave
Concavo convex	Convexo concave

The focus of a lens is the point where the refracted rays meet.

Spherical Aberration. The reflected rays of concave spherical mirrors do not meet exactly the same point. This is called spherical aberration.

Effect of Spherical Aberration. It produces a lack of sharpness and defination of an image. If a ground glass screen be placed exactly in the focus of a lens the image of an object will be sharply defined in the center but indistinct at the edges, and if sharp at the edges it will be indistinct at the center. To avoid this a disc with a hole in the center is placed concentric with the principal axis of the lens, thus only the center part of the lens is used.

Chromatic Aberration. When white light is passed through a spherical lens, both refraction and dispersion (the decomposition of white light into several kinds of light) occur. This causes a separation of the white light into the various colors and causes images to have colored edges. This effect which is most observable in condenser lenses is due to the unequal refrangibility of the simple colors.

Achromatic Lenses. The color effect caused by the chromatic aberration of a simple lens greatly impairs its usefulness. This may be overcome by combining

into one lens, a convex lens of crown glass and a concave lens of flint glass.

Back Focal Length. The distance from the back of the lens to the film in the gate of machine while the film is in focus on the screen. (Written B. F.)

Equivalent Focus. The distance from a point half way between the back and front combination of lenses to the film in the gate while picture is in focus on screen.

Can be obtained by measuring the distance between the front and back combination then dividing by two and adding the result to the back focal length. (Written E. F.)

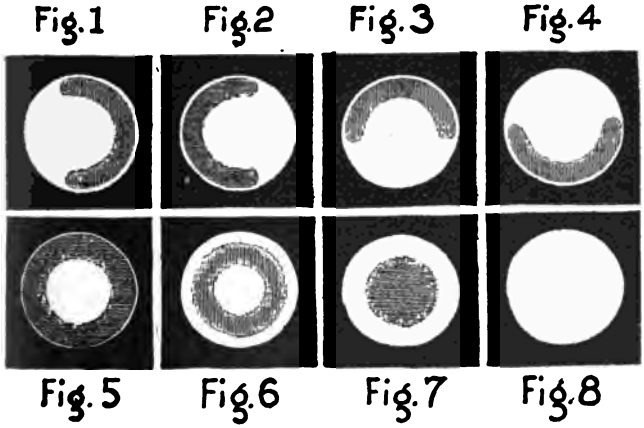
Objective Lens. The objective lens of a moving picture machine generally consists of four lenses, two in the front combination and two in the rear. The two lenses in the front are cemented together with Canada Balsam and called the compound lens. The back combination consists of two lenses separated by a metal ring, called the duplex lens.

The convex or greatest convex side of a lens always faces the screen.

It is absolutely necessary to keep the lenses clean, it will be impossible to get good definition or sharp focus on the screen if the objective lens is not scrupulously clean. Never place the fingers on the glass surface of lens, as though it may not show when looking through the lens it will undoubtedly affect the definition of picture on screen.

Condenser lenses should be cleaned every day, and the objective lens once or twice a week. It will not be

found necessary to take the lens apart to do this, as it will only be the exposed glass surfaces that will need attention. Use a clean soft handkerchief for this purpose. The lens can be taken apart every three or four months and all surfaces thoroughly cleaned, great care should be taken when taking the lens apart so that you get the lenses back in the same position and order.

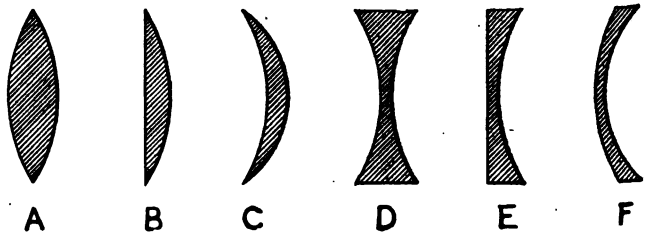


Successful results in projection depend largely upon the correct adjustment of the lamp, which must throw a brilliantly illuminated clear circle on the screen. After the objective is focused as will be evidenced by a sharp, clear image on the screen, examine the illuminated circle. If the light be centered and the lamp correctly adjusted, the circle will be entirely free from coloration or shadows. In Figures 1 and 2 the crater of arc needs to be properly adjusted laterally, it being as shown too far to the right or left. Figures 3 and 4

show the crater too high or too low. In Figures 5, 6 and 7 the crater is too near or too far away from condensers. Figure 8 shows it in right position, the screen being free from all shadows or ghosts.

This shows the various lenses: (*a*) double convex; (*b*) plano convex; (*c*) concavo convex; (*d*) double concave; (*e*) plano concave; (*f*) convexo concave.

The first three are thicker at the center than at the border, and are called converging; the second three which are thinner at the center are called diverging.



LENS TABLE OF FILM PROJECTION

DISTANCE FROM FILM TO SCREEN

Stero.	M. P.	15	20	25	30	35	40	45
8	2	5.04	6.74	8.44	10.14	11.84	13.54	15.24
		6.72	8.99	11.25	13.52	15.78	18.05	20.31
9	2¼	4.48	5.99	7.50	9.01	10.52	12.03	13.54
		5.97	7.98	10.00	12.01	14.03	16.04	18.05
10	2½	4.02	5.38	6.74	8.10	9.46	10.82	12.18
		5.36	7.17	8.99	10.80	12.61	14.42	16.24
11	2¾	3.65	4.89	6.12	7.36	8.59	9.83	11.06
		4.87	6.52	8.17	9.18	11.46	13.11	14.76
12	3	3.34	4.47	5.61	6.74	7.87	9.00	10.14
		4.46	5.97	7.48	8.99	10.50	12.01	13.52
13	3¼	3.08	4.13	5.17	6.22	7.26	8.31	9.35
		4.11	5.50	6.90	8.19	9.69	11.08	12.48
14	3½	2.86	3.83	4.80	5.77	6.74	7.72	8.69
		3.81	5.10	6.40	7.69	8.99	10.28	11.58
15	3¾	2.66	3.57	4.47	5.38	6.28	7.19	8.10
		3.55	4.76	5.97	7.17	8.38	9.59	10.80
16	4	2.49	3.34	4.19	5.04	5.98	6.74	7.59
		3.32	4.45	5.59	6.72	7.85	8.98	10.12
17	4¼	2.34	3.14	3.94	4.74	5.54	6.34	7.14
		3.12	4.19	5.25	6.32	7.38	8.45	9.52
18	4½	2.21	2.97	3.72	4.48	5.23	5.99	6.74
		2.95	3.96	4.96	5.97	6.98	7.98	8.99
19	4¾	2.09	2.81	3.52	4.24	4.95	5.67	6.38
		2.79	3.74	4.70	5.65	6.61	7.56	8.51
20	5	1.98	2.66	3 34	4.02	4.70	5.38	6.06
		2.64	3.55	4.45	5.36	6.27	7.17	8.08
21	5¼	1.89	2.54	3.18	3.83	4.48	5.13	5.77
		2.51	3.37	4.24	5.10	5.96	6.83	7.69
22	5½	1.80	2.42	3.04	3.65	4.27	4.89	5.51
		2.40	3.22	4.05	4.87	5.70	6.52	7.34
23	5¾	1.72	2.31	2.90	3.49	4.08	4.67	5.27
		2.29	3.08	3.87	4.65	5.44	6.23	7.02
24	6	1.64	2.21	2.77	3.34	3.91	4.47	5.04
		2.19	2.95	3.70	4.46	5.21	5.97	6.72
25	6¼	1.57	2.11	2.66	3.20	3.75	4.29	4.83
		2.10	2.82	3.55	4.27	5.00	5.72	6.45
26	6½	1.51	2.03	2.56	3.08	3.60	4.12	4.65
		2.02	2.72	3.41	4.11	4.81	5.51	6.20
27	6¾	1.45	1.95	2.46	2.96	3.46	3.97	4.47
		1.94	2.61	3.28	3.95	4.63	5.30	5.97
28	7	1.40	1.89	2.37	2.86	3.34	3.83	4.31
		1.87	2.52	3.16	3.81	4.46	5.11	5.75
29	7¼	1.35	1.82	2.29	2.76	3.23	3.69	4.16
		1.80	2.42	3.05	3.67	4.30	4.92	5.69
30	7½	1.30	1.75	2.21	2.66	3.11	3.57	4.02
		1.74	2.34	2.95	3.55	4.16	4.76	5.37
31	7¾	1.26	1.70	2.14	2.58	3.01	3.45	3.89
		1.68	2.26	2.85	3.43	4.02	4.60	5.19
32	8	1.22	1.64	2.07	2.49	2.92	3.34	3.77
		1.62	2.19	2.75	3.32	3.89	4.45	5.02
33	8¼	1.18	1.59	2.00	2.42	2.83	3.24	3.65
		1.57	2.12	2.67	3.22	3.77	4.32	4.87
34	8½	1.14	1.54	1.94	2.34	2.74	3.14	3.54
		1.52	2.05	2.59	3.12	3.65	4.19	4.72
35	8¾	1.11	1.50	1.88	2.27	2.66	3.05	3.43
		1.48	2.00	2.51	3.03	3.55	4.06	4.58

LENS TABLE OF FILM PROJECTION—*Continued*

DISTANCE FROM FILM TO SCREEN

Stereo.	*M. P.*	*50*	*56*	*60*	*64*	*70*	*76*	*80*
8	2	16.93	18.97	20.33	21.69	23.73	25.77	27.13
		22.58	25.30	27.11	28.92	31.64	34.46	36.17
9	2¼	15.05	16.87	18.07	19.28	21.09	22.91	24.12
		20.07	22.48	24.10	25.71	28.12	30.54	32.15
10	2½	13.54	15.17	16.26	17.34	18.98	20.61	21.70
		18.05	20.22	21.67	23.12	25.30	27.47	28.92
11	2¾	12.30	13.78	14.77	15.76	17.24	18.73	19.72
		16.40	18.38	19.70	21.01	22.99	24.97	26.29
12	3	11.27	12.63	13.54	14.44	15.80	17.16	18.07
		15.03	16.85	18.05	19.26	21.07	22.89	24.10
13	3¼	10.40	11.65	12.49	13.33	14.58	15.84	16.67
		13.87	15.54	16.66	17.77	19.45	21.12	22.23
14	3½	9.66	10.82	11.60	12.38	13.54	14.71	15.48
		12.87	14.43	15.46	16.50	18.05	19.60	20.64
15	3¾	9.00	10.09	10.82	11.54	12.63	13.72	14.44
		12.00	13.46	14.42	15.39	16.84	18.29	19.26
16	4	8.44	9.46	10.14	10.82	11.84	12.86	13.54
		11.25	12.61	13.52	14.42	15.78	17.14	18.05
17	4¼	7.94	8.90	9.54	10.18	11.14	12.10	12.74
		10.58	11.86	12.72	13.57	14.85	16.13	16.98
18	4½	7.50	8.40	9.01	9.61	10.52	11.42	12.03
		9.10	11.21	12.01	12.82	14.03	15.23	16.04
19	4¾	7.10	7.96	8.53	9.10	9.96	10.82	11.39
		9.47	10.61	11.38	12.14	13.28	14.43	15.19
20	5	6.74	7.55	8.10	8.64	9.46	10.27	10.82
		8.98	10.07	10.80	11.52	12.62	13.70	14.42
21	5¼	6.42	7.20	7.72	8.23	9.01	9.79	10.30
		8.55	9.59	10.28	10.97	12.00	13.04	13.73
22	5½	6.13	6.87	7.36	7.86	8.60	9.34	9.83
		8.17	9.16	9.82	10.47	11.46	12.45	13.11
23	5¾	5.86	6.57	7.04	7.51	8.22	8.93	9.40
		7.81	8.75	9.38	10.01	10.96	11.90	12.53
24	6	5.60	6.28	6.74	7.19	7.87	8.55	9.00
		7.48	8.38	8.99	9.59	10.50	11.40	12.01
25	6¼	5.38	6.03	6.46	6.90	7.55	8.20	8.64
		7.17	8.04	8.62	9.20	10.07	10.94	11.52
26	6½	5.17	5.80	6.22	6.63	7.26	7.89	8.31
		6.90	7.74	8.39	8.85	9.69	10.53	11.08
27	6¾	4.98	5.58	5.98	6.38	6.99	7.59	8.00
		6.64	7.44	7.98	8.52	9.32	10.13	10.67
28	7	4.80	5.38	5.77	6.16	6.74	7.32	7.71
		6.40	7.18	7.70	8.21	8.99	9.77	10.28
29	7¼	4.63	5.19	5.57	5.94	6.51	7.07	7.44
		6.17	6.92	7.42	7.92	8.67	9.43	9.93
30	7½	4.47	5.02	5.38	5.74	6.28	6.83	7.19
		5.97	6.69	7.18	7.66	8.39	9.11	9.59
31	7¾	4.33	4.86	5.21	5.56	6.08	6.61	6.96
		5.77	6.48	6.95	7.42	8.12	8.82	9.29
32	8	4.19	4.70	5.04	5.38	5.89	6.40	6.74
		5.58	6.26	6.72	7.17	7.85	8.53	8.98
33	8¼	4.06	4.56	4.89	5.22	5.71	6.21	6.54
		5.41	6.07	6.51	6.95	7.61	8.27	8.71
34	8½	3.94	4.42	4.74	5.06	5.54	6.02	6.34
		5.25	5.89	6.32	6.74	7.38	8.02	8.44
35	8¾	3.82	4.29	4.60	4.91	5.38	5.84	6.15
		5.10	5.72	6.13	5.65	7.17	7.79	8.20

LENS TABLE OF FILM PROJECTION—*Continued*

DISTANCE FROM FILM TO SCREEN

Stero.	*M. P.*	*84*	*90*	*96*	*100*	*104*	*110*	*116*
8	2	28.49	30.53	32.57	33.93	35.29	37.33	39.36
		37.99	40.71	43.42	45.24	47.05	49.77	52.49
9	2¼	25.32	27.14	28.95	30.16	31.37	23.18	34.99
		33.76	36.18	38.60	40.21	41.82	44.24	46.55
10	2½	22.78	24.42	26.05	27.14	28.22	29.86	31.49
		30.37	32.55	34.72	36.17	37.62	39.80	41.97
11	2¾	20.70	22.19	23.67	24.66	25.65	27.13	28.61
		27.61	29.59	31.56	32.88	34.20	36.18	38.15
12	3	18.97	20.33	21.69	22.60	23.50	24.86	26.22
		25.30	27.12	28.93	30.14	31.35	33.16	34.97
13	3¼	17.51	18.77	20.02	20.86	21.69	22.95	24.20
		23.35	25.02	26.70	27.81	28.93	30.60	32.27
14	3½	16.26	17.43	18.59	19.37	20.14	21.31	22.47
		21.68	23.23	24.78	25.82	26.86	28.41	29.96
15	3¾	15.17	16.25	17.34	18.07	18.79	19.88	20.97
		20.22	21.67	23.12	24.09	25.06	26.51	27.96
16	4	14.22	15.24	16.25	16.93	17.61	18.63	19.65
		18.95	20.31	21.67	22.58	23.48	24.84	26.20
17	4¼	13.38	14.34	15.30	15.94	16.57	16.52	18.48
		17.83	19.11	20.39	21.25	22.10	23.38	24.66
18	4½	12.63	13.54	14.44	15.05	15.65	16.56	17.47
		16.85	18.05	19.26	20.07	20.87	22.08	23.29
19	4¾	11.96	12.82	13.68	14.25	14.83	15.86	16.54
		15.96	17.10	18.24	19.10	19.77	20.92	22.06
20	5	11.36	12.28	12.99	13.54	14.08	14.89	15.71
		15.15	16.23	17.32	18.05	18.77	19.86	20.95
21	5¼	10.82	11.60	12.38	12.89	13.41	14.19	14.96
		14.42	15.46	16.49	17.18	17.87	18.91	19.94
22	5½	10.33	11.07	11.81	12.31	12.80	13.54	14.28
		13.77	14.76	15.73	16.40	17.07	18.06	19.04
23	5¾	9.88	10.59	11.29	11.77	12.24	12.95	13.66
		13.16	14.11	15.06	15.69	16.32	17.26	18.21
24	6	9.46	10.14	10.82	11.27	11.72	12.40	13.08
		12.61	13.52	14.42	15.03	15.63	16.54	17.45
25	6¼	9.07	9.73	10.38	10.81	11.25	11.90	12.55
		2.10	12.97	13.84	14.42	15.00	15.87	16.74
26	6½	8.72	9.35	9.98	10.40	10.82	11.44	12.07
		11.64	12.48	13.31	13.87	14.43	15.27	16.10
27	6¾	8.40	9.00	9.60	10.01	10.41	11.02	11.62
		11.20	12.01	12.81	13.35	13.89	14.69	15.50
28	7	8.10	8.68	9.27	9.65	10.04	10.62	11.21
		10.80	11.58	12.36	12.87	13.39	14.17	14.94
29	7¼	7.82	8.38	8.94	9.32	9.69	10.26	10.82
		10.42	11.17	11.93	12.43	12.93	13.68	14.43
30	7½	7.55	8.10	8.64	9.00	9.37	9.91	10.45
		10.08	10.80	11.53	12.01	12.50	13.22	13.95
31	7¾	7.31	7.84	8.36	8.71	9.07	9.59	10.12
		9.76	10.46	11.16	11.63	12.10	12.80	13.50
32	8	7.08	7.59	8.10	8.44	8.78	9.29	9.80
		9.44	10.12	10.80	11.25	11.70	12.38	13.06
33	8¼	6.86	7.36	7.85	8.18	8.51	9.01	9.50
		9.15	9.81	10.47	10.91	11.35	12.01	12.66
34	8½	6.66	7.14	7.62	7.94	8.26	8.74	9.22
		8.88	9.52	10.16	10.58	11.01	11.65	12.29
35	8¾	6.46	6.93	7.40	7.71	8.02	8.48	8.95
		8.62	9.24	9.86	10.27	10.6	11.31	11.93

The use of panel board and transformers is made clear to class in motion picture projection

LIGHT

That light travels with a speed, which is much greater than the speed of sound is shown by the fact that the flash of a distant gun is always seen long before the sound of the report is heard and that lightning always precedes thunder.

For most purposes it is sufficiently accurate to take the velocity of light as 186,000 miles per second.

Light always travels out from a source in straight lines.

Up till the year 1800, the Corpuscular theory of light was the one most generally accepted, that light consists of streams of very minute particles, or corpuscles projected with the enormous velocity of 186,000 miles per second from all luminous bodies. The facts of straight line propagation and reflection are exactly as we should expect them to be if this were the nature of light.

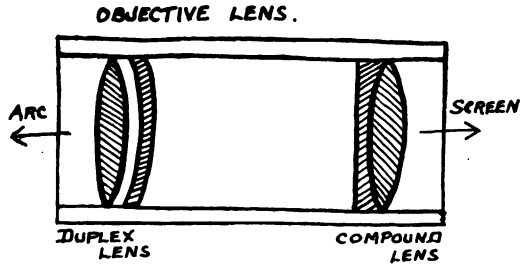
A usual hypothesis which was first completely formulated by the great Dutch physicist—Huygens (1629–1695), regarded light like sound, as a form of wave motion. This hypothesis met at the first with two very serious difficulties; in the first place light, unlike sound, not only travels with perfect readiness through the best vacuum which can be obtained with an air pump, but it travels without any apparent difficulty through the great interstellar spaces which are probably infinitely better vacua than can be obtained by artificial means. If therefore, light is a wave motion,

it must be a wave motion of some medium which fills all space and yet which does not hinder the motion of the stars and planets. Huygens assumed such a medium to exist, and called it ether.

The second difficulty in the way of the wave theory of light, was that it seemed to fail to account for the fact of straight line propagation. Sound waves, water waves and all other forms of waves with which we are familiar bend readily around corners, while light apparently does not. It was this difficulty chiefly which led many of the famous philosophers, including the great Sir Isaac Newton, to reject the wave theory and to support the projected particle theory.

Within the last hundred years, however, this difficulty has been completely removed and in addition other properties of light have been discovered, for which the wave theory offers the only satisfactory explanation. If the wave theory is to be accepted, we must conceive with Huygens, that all space is filled with a medium, called the ether, in which the waves can travel. This medium cannot be like any of the ordinary forms of matter; for if any of these forms existed in interplanetary space, the planets and the other heavenly bodies would certainly be retarded in their motion. As a matter of fact, in all the hundreds of years during which astronomers have been making accurate observation of the motion of heavenly bodies no such retardation has ever been observed. The medium which transmits light waves, must therefore have a density which is infinitely smaller even in comparison with that of our lightest gases. The existence of such a medium is now universally assumed by physicists.

Just as sound waves are disturbances set up in the air by the vibrations of bodies of ordinary dimensions, so light waves are disturbances set up in the ether probably by the vibrations of the minute corpuscles or electrons, of which the atoms of ordinary matter are supposed to be built up. Since these corpuscles are extremely small in comparison with ordinary bodies it is not surprising that their rates of vibration are enormously larger than the vibration rates of tuning forks, or other bodies which send out sound waves. Just how these corpuscles are set into vibration and in just what manner they vibrate, we cannot say as yet with certainty, but since we do know that an increase in the temperature of all bodies means an increase in the agitation of the molecules and atoms of which these bodies are composed. It is not surprising that the vibrations which communicate light waves to the ether take place in general in bodies which have a high temperature and that the hotter the body becomes the more intense becomes the light waves which it emits.



Position of lenses in objective lens

PLATE 1

PLATE 2

PLATE 3

PLATE 4

THREADING THE SIMPLEX PROJECTOR

Plate I shows the method of threading the film through the fire trap, and under the top sprocket.

Plate II shows how the film is threaded through the gate of machine, by forming the upper loop, with the second finger of the left hand and gripping the film below the intermittent sprocket with the first and third fingers of the right hand and closing the gate by tripping the gate spring with the second finger.

Plate III illustrates the method of forming the lower loop, threading the film over the lower sprocket, and closing the lower idler by a downward pressure with the first finger of the right hand. The film is then threaded through the lower fire trap and fastened to the reel in lower magazine.

Plate IV shows the machine completely threaded.

Be sure and see that the sprocket teeth engage in the holes of film.

See that the film goes in upside down and emulsion side to some of light.

Don't forget to leave film loops between upper sprocket and intermittent sprocket and between intermittent sprocket and lower sprocket.

See that the film is caught on lower reel before starting the motor.

Students at Red Cross Institute observing the operation of the arc lamp

QUESTIONS AND ANSWERS

Ques. What is a gramme?

Ans. Unit of weight, the weight of a cubic centimeter of water at a temperature of 4 degrees centigrade.

Ques. What is a centimeter?

Ans. The unit of length, one thousandth millionth part of a quadrant of the earth's surface.

Ques. What is a coulomb?

Ans. Unit of quantity—quantity of current which, impelled by one volt would pass through one ohm in one second.

Ques. What is a joule?

Ans. The unit of work, the work done by one watt in one second.

Ques. What is a circular mil?

Ans. A unit of area, a mil is one thousandth part of an inch, and a circular mil is the area of a circle whose diameter is one mil.

Ques. What is ohms law.

Ans. The current in amperes, is equal to the electric motive force in volts, divided by the resistance in ohms.

EXAMPLE. If we had 100 volts and 4 ohms resistance in our circuit we would get the amperage, (current), by dividing 100 (volts) by 4 (ohms) which would equal 25 amperes.

The resistance in ohms, is equal to the electric motive force in volts, divided by the current in amperes.

EXAMPLE. If we had 100 volts and 25 amperes then by dividing 100 (volts) by 25 (amperes) we would get 4 (ohms).

The electric motive force is equal to the current in amperes multiplied by the resistance in ohms.

EXAMPLE. If we had 25 amperes and 4 ohms resistance and we multiplied them we would get 100 (volts).

Ques. How would you judge what size fuse you would use on your line?

Ans. Take into consideration the size of the wire and the amperage to be drawn, the fuse must be the weakest part of the circuit.

Ques. What is meant by conductor? What is generally used for this purpose?

Ans. Anything that allows the passage of electricity through it. Copper.

Ques. What is the carrying capacity of a No. 6 rubber covered wire?

Ans. 50 amperes.

Ques. What is the carrying capacity of a No. 6 weatherproof wire?

Ans. 65 amperes.

Ques. Name the three kinds of wire used in moving picture work.

Ans. Rubber covered wire for mains, asbestos covered wire for lamp leads used between the table switch and the arc lamp (wherever heat is generated) and stage cable used for one night stands.

Ques. State if rubber covered wire, weather-proof wire and asbestos wire are all fire-proof?

Ans. No, weather-proof wire is moisture proof but not fire-proof.

Ques. What size wire would you use for your mains for moving picture work?

Ans. Size 6 or larger.

Ques. What size wire would you use for your motor connections and what size fuse?

Ans. Size 14 wire and a 6 ampere fuse.

Ques. What is the carrying capacity of a 14 wire?

Ans. 15 amperes.

Ques. On direct current which wire would you connect to the top carbon?

Ans. The positive.

Ques. On which line, your positive or negative would you connect your rheostat?

Ans. On either line it makes no difference.

Ques. On which line would you connect a transformer?

Ans. A transformer must be connected to both lines of a circuit.

Ques. What is asbestos covered wire?

Ans. A cable containing very fine strands of copper wires all twisted together and the whole thing covered with asbestos.

Ques. What is rubber covered wire?

Ans. A cable either solid or stranded covered with a rubber covering and an outer protective covering of cotton braid.

Ques. What is stage cable?

Ans. A cable containing twin conductors each insulated from the other and wrapped with a composition covering.

Ques. How would you connect a lug to one of the lamp leads?

Ans. After scraping off the asbestos insulation would insert cable into hole of lug and would tighten up with pliers.

Ques. What is a short circuit?

Ans. Two wires of opposite polarity coming in contact with each other without any controlling device.

Ques. What is a rheostat and how is it constructed?

Ans. An instrument used on your line to produce resistance and bring the current to a fixed working standard.

It is made of a number of metal coils or plates (generally iron or german silver) connected in series and mounted on some insulated material, the whole thing being enclosed in a metal cabinet.

Rheostats are made both adjustable and non-adjustable.

Ques. Can you use rheostats on A. C. or D. C.?

Ans. Rheostats can be used on both A. C. and D. C. but it is cheaper to use an economizer or a transformer instead of a rheostat on A. C.

Ques. How many rheostats would you use on 110 volts?

Ans. One 110 volt rheostat in series on your line.

Ques. If automatic shutter on Powers machine refused to raise when machine started what would you do?

Ans. Put a little oil in oil hole in top of movement; if it still refused to raise, would take off casing and see if shoes or springs were caught or dirty.

Ques. Suppose the automatic shutter raised up when machine started but would not stay up what would you do?

Ans. Put a little heavy oil in movement.

Ques. Suppose the automatic shutter did not drop when machine stopped how would you fix it?

Ans. Put a little thin oil in movement, and if this failed examine shoes and springs.

Ques. What controls the size of the picture on the screen?

Ans. The focal length of the lens and the distance of machine from screen.

Ques. What would cause a travel ghost on screen?

Ans. The flicker shutter not being adjusted right.

Ques. What would happen if the take-up belt refused to drive take-up or fell off while the machine was running?

Ans. Film would bunch up around lower sprocket and then fall on floor.

Ques. Name six revolving parts on the head of machine leaving out the sprockets and idlers?

Ans. Flicker shutter, balance wheel, intermittent movement, centrifugal movement, take-up and gears.

Ques. Name the fire prevention devices on the head of machine.

Ans. Upper and lower magazines, upper and lower fire traps, upper and lower fire shields, automatic shutter, cooling plate.

Ques. In threading machine how would you put in film?

Ans. Upside down and the emulsion side towards lamp house.

Ques. What comprises the optical system in a moving picture circuit?

Ans. The source of light, condensers and lens.

Ques. Name some of the various kinds of lenses.

Ans. Double convex, double concave, plano convex, plano concave, concavo-convex.

Ques. What is meant by the back focal length of a lens?

Ans. The distance from the back of the lens to the film in gate while the picture is in focus on screen.

Ques. Of what use are the condensers?

Ans. To bring the light of arc lamp to a point of focus on aperture in gate.

Ques. Which end of the lens goes towards the screen?

Ans. The greatest convex side.

Ques. What is meant by a keystone effect?

Ans. When the machine is set up above the level of the screen and it is necessary to tilt the machine, the bottom of the picture will be wider than the top, owing

to the light rays having to travel further to the bottom of the screen than to the top.

Ques. Give your definition of motion pictures.

Ans. An optical illusion based on the persistence of vision.

Ques. What is a fuse, and how many kinds are there?

Ans. A fuse is a safety device used on your line to protect your circuit. Plug fuses, cartridge fuses and link fuses.

Ques. How many sets of fuses do you use on your line for motion picture work and what would you call them?

Ans. Two, main and booth fuses.

Ques. What size fuse would you use at the main and what size at booth, using No. 6 wire?

Ans. Fifty ampere cartridge fuse at main and 45 ampere link fuse in booth.

Ques. Why not use a 45 ampere cartridge fuse in booth?

Ans. The department calls for the use of link fuses only; the reason cartridge fuses cannot be used in booth is that cartridge fuses are easily tampered with or boosted.

Ques. Why do you use a smaller size fuse in the booth than you do on your mains?

Ans. So that in case of trouble the fuse in the booth will go first (it being the weakest part of the circuit) and you will not have to run down to main fuses in cellar as you would have to do if main fuses were to blow.

Ques. How would you install a link fuse?

Ans. On a slate base in a metal cabinet fitted with a self-closing door.

Ques. What would happen on your line if you got a short circuit?

Ans. Blow your fuses.

Ques. Can you use a 60 ampere cartridge fuse on your mains on a No. 6 wire?

Ans. No, as this would be overfusing, the carrying capacity of a No. 6 wire is 50 amperes, and the fuses must be the weakest part of your circuit.

Ques. What is an ampere, a volt and an ohm?

Ans. The ampere is the unit of current, the volt is the unit of electric motive force (or pressure), and the ohm is the unit of electrical resistance.

Ques. What is a watt?

Ans. The electrical unit of power. Amperes times volts equals watts.

Ques. What is a kilowatt?

Ans. 1,000 watts equals one kilowatt.

Ques. How many watts in one horse power?

Ans. 746 watts equal one horse power.

Ques. What is an ampere-hour?

Ans. Current in amperes multiplied by time in hours.

Ques. What is a second?

Ans. The unit of time, the time of one swing of a pendulum making 86,400 swings in a solar day.

Ques. What is meant by the safe carrying capacity of wires?

Ans. All wires will heat when a current of electricity passes through them. The greater the current or the smaller the wire, the greater will be the heating effect. Large wires are heated comparatively more than small wires because the latter have a relatively greater radiating surface.

Ques. What parts of a dynamo are liable to be short circuited?

Ans. The terminals, brush holders, commutator, armature coils and field coils.

Ques. Suppose on looking over your motor you found that there were several ridges on the commutator, where would you look for the cause?

Ans. The brushes are not set right or the tension of brushes on commutator is too great.

Ques. How would you go about setting a Simplex flicker shutter?

Ans. When setting the shutter, set the framing lever in center, move the shutter adjusting block to a point equidistant between the two pins by means of the knob on the back of the mechanism facing towards lamp house. Four teeth on intermittent sprocket represents one full move of one section on star, moving the sprocket two teeth either backward or forward would mean center. Now adjust shutter as follows: On a three wing shutter the center of the blade with the word "Simplex" stamped on it should be on center with the lens; on a two wing shutter the center of either blade will cover the lens. The position can best be determined

by the set screw on the spider, which should face the operator in a horizontal position. In setting shutter always keep as close to the lens as possible.

Ques. What is a D. C. to D. C. motor generator?

Ans. It is a D. C. motor connected to a D. C. generator, used to give a D. C. controlled light at arc, thereby doing away with the use of rheostats. When we take into consideration the fact that a rheostat on 110 volt circuit wastes from 35% to 50% of the current, and on 220 volts, rheostats wastes from 65% to 75% it will be easily seen why a D. C. generator should be installed in place of rheostats.

Ques. Show by figures what would be the saving if you installed a Hallberg D. C. generator and discarded your rheostats, taking it for granted that you were drawing 80 amperes at the arc on a 110 volt circuit?

Ans. With rheostats we would be consuming 110 volts times 80 amperes or 8,800 watts while with the generator we would be consuming 110 volts times 57 amperes (this being the amount of current generator draws from line) or 6,270 watts. With rheostats we consume 8,800 watts per hour while with generator we only consume 6,270 watts per hour, the generator showing a saving of 1,530 watts per hour.

Ques. State what advantage a motor generator has over rheostats aside from the question of current saving.

Ans. You do away with the heat generated by the rheostats.

Ques. What is a Hallberg 4 in 1 automatic regulator?

Ans. Consists of an adjustable transformer with separate line and lamp coils. The primary coil is

wound in two sections each section insulated from the other. Each section is wound for 110 volts. For 110 volts you connect the two sections in multiple while for 220 volts you connect the two sections in series. It is used for moving picture circuits when using the mazda lamp instead of arc. (See page 33.)

Ques. What is meant by stealing the arc?

Ans. When two arcs are connected to one source of supply, as when two arcs are connected to one generator, and where the striking of the second arc automatically puts out or draws from the first arc.

Ques. What is meant by the strength of a current?

Ans. The quantity of electricity which flows past any point of the circuit in one second.

Ques. What is the difference between a dynamo and an alternator?

Ans. A dynamo generates D. C. while an alternator generates A. C.

Ques. Suppose you had one 110 volt 25 ampere rheostat connected on a 110 volt circuit D. C. and you had one 110 volt 25 ampere rheostat connected on a 110 volt circuit A. C. at which arc would you draw the most amperage and why?

Ans. On the A. C. arc because with A. C. you have to feed the carbons closer together than on D. C. and that draws a little more amperage.

Ques. How does a dynamo create current?

Ans. It does not create current but generates an induced E. M. F. which causes a current to flow through a circuit.

Ques. How should a knife switch be installed?

Ans. So that gravity tends to open same.

Ques. Is it possible to reverse the rotation of a motor, if so how?

Ans. Yes, by reversing the current through the fields or the current through the armature.

Ques. What is the difference between a D. C. and an A. C. rheostat?

Ans. Rheostats are made for either A. C. or D. C. There is no difference between them.

Ques. How many rheostats would you use on 220 volts and how would you connect same?

Ans. One 220 volt rheostat in series with your line or two 110 volt rheostats in series with each other and in series on your line.

Ques. With 55 volts coming in, how many rheostats would you use, and how would you connect same?

Ans. Use two 110 volt rheostats in multiple with each other and in series on your line.

Ques. What effect does it have by connecting rheostats in multiple and rheostats in series?

Ans. Rheostats in series gives you the sum of their resistance, for instance if they each offered 4 ohms resistance and we connected same in series with each other we would have 8 ohms resistance on our line. If we connected the same two rheostats in multiple we would only then have approximately 2 ohms resistance.

Ques. Why don't they use copper coils instead of iron in a rheostat?

Ans. Because iron offers more resistance than copper, copper being a good conductor.

Ques. Is all the resistance offered in your rheostat?

Ans. No, everything on your line offers resistance, all substance offers resistance to the passage of electricity through them, the amount of resistance depending on the substance and its size, that is on its length and cross section.

Ques. Do metals offer more or less resistance when hot?

Ans. The resistance of all metals increases with an increase of temperature, while carbons and insulating materials decrease with an increase of temperature.

Ques. Is it possible to get a short circuit in the rheostat?

Ans. Yes, when the arc lamp is burning, as you then have two polarities in rheostat.

Ques. How many kinds of current are there and state what they are.

Ans. Two, direct current and alternating current.

Ques. What is meant by direct current?

Ans. Direct current is a current that always flows in the same direction; always leaves the dynamo through the positive pole and returns through the negative pole.

Ques. What is alternating current?

Ans. Alternating current is a current that changes its flow of direction so many times a second. Each part of the circuit being so many times positive and so many times negative every second.

Ques. What is current frequency?

Ans. The number of times alternating current changes its flow of direction in a second. (These changes are called cycles).

Ques. Which current is the best for moving picture work and why?

Ans. Direct current, gives a better arc, more easily controlled, and is not so noisy as A. C.

Ques. Is it possible to change A. C. into D. C.?

Ans. Yes, there are various machines on the market for this purpose—transverters, arc rectifiers and motor generator sets.

Ques. Suppose you had 110 volts D. C. coming into the theatre and you had one 110 volt rheostat on your line, and then the current was changed from D. C. to A. C. what changes would you make on your line and state reasons why.

Ans. Would take off the rheostat and install an economizer (step-down transformer) this would give me a saving of about 66% (makers claim).

Ques. Suppose you changed a rheostat for an economizer on a 220 volt line, would there be a saving? If so, about how much?

Ans. About 80% (makers claim).

Ques. State an easy way to test whether you have A. C. or D. C. at arc lamp, and if you are on D. C. whether you are connected right (positive line connected to top carbon).

Ans. First strike the arc and let it burn a second or two, then throw off the switch and open lamp house

door, if both carbons remain red for the same length of time we have A. C. but should one carbon remain red longer than the other we have D. C. The top carbon should remain red longest, so if the bottom remains red longer than the top one we know that we are burning upside down. (Positive line is connected to bottom carbon instead of to top.)

Ques. Suppose you find you are burning upside down, where on your line would you make the change?

Ans. At table switch, arc lamp or wall switch.

Ques. Could you change polarity at the rheostat if you were burning upside down?

Ans. No, as you have only one polarity at the rheostat.

Ques. What is meant by constant current type of a current rectifying device?

Ans. Where two arc lamps are connected to one apparatus like a transverter or a motor generator, and where the voltage and not the amperage is doubled when both arcs are struck. For instance if we had one arc operating at 55 volts and 50 amperes and we struck the second arc we should then have two arcs operating at 50 amperes 110 volts (approximately).

Ques. What is a three wire system?

Ans. A distribution system invented by Edison, where two dynamos are connected in series and the third or neutral wire is taken from a point common to both dynamos.

Ques. How many rheostats would you use if you were using the two outside wires of a three wire system?

Ans. Two 110 volt rheostats in series with each other, as between the outside wires we would have 220 volts.

Ques. Suppose you were drawing 50 amperes off one side of a three wire system and 40 amperes off the other, how many amperes would be flowing in the neutral wire?

Ans. As the amount of current in the neutral wire is the difference between the amperage drawn off either side, we would have a flow of 10 amperes in the neutral wire.

Ques. Suppose that we were drawing 45 amperes off either side of a three wire system what would be the amount of amperage flowing in the neutral wire?

Ans. If we were drawing 45 amperes off each side of the system, the system would be balanced and there would be no flow of current in the neutral wire.

Ques. What are the advantages of a three wire system?

Ans. The saving of copper is the advantage of the system, as by its use the size of the conductors may be reduced, by increasing the pressure at which the current is transmitted, without increasing the voltage of the lamps. If for example the neutral wire is made the same size as the two outside wires, the total weight of the copper for the three wire system, will be three-eighths (3-8) of that required for two, two wire systems for the same load, distance and percentage of loss.

Ques. What are the disadvantages of a three wire system?

Ans. The system is more complicated, the cost of the switches, panel boards, etc., is increased, that the

system is more subject to disturbances, if for example the fuse on the neutral wire should melt, the lamps on the system might be considerably damaged in case the two sides of the system were not balanced.

Ques. Can you connect between the positive and neutral wire for moving picture work?

Ans. Yes, you will then need one 110 volt rheostat.

Ques. Which wire on a three wire system is grounded?

Ans. The neutral wire.

Ques. If we were connected on the positive and neutral wires of a three wire system, and we got a ground on the lower jaw of arc lamp, would that blow the fuse.

Ans. No, all metal machines must be grounded, and by so doing the lamp house becomes the same polarity as the neutral wire. Therefore the ground being on lower jaw which is neutral and the same polarity as lamp house, it may not blow the fuse.

Ques. What is a transformer, how is it made and how does it work?

Ans. A transformer consists of two copper coils, the primary and the secondary, and a laminated iron core. The two coils are insulated from one another and from the core. The primary coil is connected to the source of supply and the secondary is connected to the lamp. As a matter of fact these coils are each usually made of several sections. The voltage induced in the secondary coil is equal to the voltage impressed on the primary coil multiplied by the ratio of the number of turns in the secondary to the number in the primary coil, less a

certain drop due to impedance of the coils and to magnetic leakage. This drop is negligible on no load. Step-up transformers are used to raise the voltage. Step-down transformers are used to step down the voltage. The efficiencies of transformers are high, varying from 94% to 95% at one-fourth load to 98% at full load for sizes above 25 K. W.

The current enters the transformer through the primary coil and the alternations of the current in this coil sets up a magnetic field in the transformer. The secondary cuts the lines of magnetic force and carries off a new current to the arc lamp.

Ques. Does a transformer change the current from A. C. to D. C.?

Ans. No, it gives off a magnetized A. C. current to arc lamp.

Ques. Can you use a transformer on direct current?

Ans. No.

Ques. Why do they make the core of a transformer of a soft metal like iron, instead of steel?

Ans. Because the softer the metal the more easily it is to magnetize and it will lose its magnetism quicker after the current has been shut off.

Ques. State in one word how an economizer or transformer works.

Ans. Induction.

Ques. What is meant by induction?

Ans. A charged body running parallel to another body (it being a conductor) tends to charge the neighboring body without any tangible form of connection.

Ques. How are the coils in a transformer or economizer connected, in multiple or series?

Ans. They are *not* connected, they are insulated from each other.

Ques. What is the difference between an economizer, an inductor and a step-down transformer?

Ans. None, they are all the same and answer the same purpose.

Ques. Where on your line would you connect your economizer and why?

Ans. Between the table switch and the arc lamp, so that by pulling the table switch you put the arc and the economizer out of commission at the same time, whereas if economizer was connected between the table switch and the wall switch it would be necessary to pull both switches or at least pull wall switch to put both out of commission.

Ques. How many working parts are there in a transformer?

Ans. None.

Ques. Where is the difference between a step-up and a step-down transformer?

Ans. In the ratio of the coil windings.

Ques. What is a transverter?

Ans. A motor generator set, an A. C. motor connected to a D. C. generator gives a D. C. current at arc lamp. Or a D. C. motor connected to a D. C. generator that gives a controlled D. C. current at arc lamp.

Ques. What is a mercury arc rectifier used for?

Ans. To change A. C. to D. C.

Ques. What is the difference between a motor, a motor generator and a generator?

Ans. A motor transforms electrical into mechanical power. A generator transforms mechanical power into electrical power. A motor generator is a device consisting of a motor mechanically connected to one or more generators.

Ques. What is the difference between a starting box and a speed regulator?

Ans. Motor starting rheostats or starting boxes are designed to start a motor and bring it gradually from rest to full speed. They are not intended to regulate speed and must not be used for that purpose. Failure to observe this caution will result in burning out the resistance which in a motor starter is sufficient to carry the current for a limited time only, whereas in a speed regulator, sufficient resistance is provided to carry the full load current continuously.

Ques. What is meant by self induction?

Ans. A characteristic of alternating current circuits, where the current tends to create a counter E. M. F. Self induction varies greatly with conditions depending upon the arrangement of the circuit, the medium surrounding the circuit, the devices or apparatus supplied or connected in the circuit, etc. For example, if a coil having a resistance of 100 ohms is included in the circuit, a current of one ampere can be passed through the coil with an electric pressure of 100 volts, if direct current is used; while it might require a potential of

several hundred volts to pass a current of one ampere if alternating current is used, depending upon the number of turns in the coil, whether it is wound on iron or some other non-magnetic material.

Ques. State six reasons for the film jumping on the screen.

Ans. Dirt on sprockets, especially the intermittent sprocket, losing the bottom loop, not enough tension in gate of machine, sprocket shaft not true, shaft bushings badly worn, holes in the films worn.

Ques. Suppose you blow the fuse when you strike the arc, where would you look for the trouble?

Ans. In the rheostat.

Ques. Suppose you blow the fuse when you close the table switch, where would you look for the trouble?

Ans. Between the table switch and the arc lamp.

Ques. If you strike the arc and only get a spark and carbons refuse to hold arc where would you look for the trouble?

Ans. Loose connection or oxidized connection in rheostat or on line.

Ques. Is it possible to get a fire on the machine, if so how?

Ans. Yes, bad patches in film opening up while going through machine, torn sprocket holes on each side of film, take-up refusing to work, automatic shutter failing to work, film breaking in gate between upper and intermittent sprocket, dirt and pieces of film gathering in film aperture in gate.

Ques. State what you would use to test for ground or open circuit in rheostat.

Ans. A bell set.

Ques. How youldd you test for ground and how for open circuit in rheostat?

Ans. First test bell set by connecting both terminals together, if you get a ring then set is all right and proceed as follows: Place one of the terminals of bell set on the frame of rheostat and the other terminal on the first coil or plate of rheostat, if you get a ring, then rheostat is grounded. If you do not get a ring then rheostat is free from ground. If grounded, to locate which plate or coil is causing the ground, proceed as follows: Place terminal of bell set on frame and other terminal on first coil, if you get a ring, disconnect first coil then test the second and so on till bell stops ringing. As soon as bell stops ringing it signifies that, the coil that you disconnected last is the coil that was grounded.

To test for open circuit, place the terminals of bell set on the terminals on rheostat and if you get a ring then rheostat is O.K.

Ques. If you were drawing 30 amperes on a 110 volt circuit, how many kilowatts would you be using?

Ans. Volts times amperage equals watts, so 110 x 30 equals 3300, and as there are 1,000 watts in a kilowatt that means that we have 3 3-10 K. W.

Ques. How would you measure a No. 6 rubber covered stranded wire?

Ans. First, scrape off the insulation, then measure one of the strands with a B. & S. wire guage, we would find that this strand would be a No. 14, then by referring

to the wire table we would find that a 14 wire contains 4,107 circular mils, then we count the strands in the cable and we find there are seven, so we multiply 4,107 by 7 which equals 28,749, then we again refer to wire table to find the nearest number to 28,749 which is 26,250 and looking across wire column we find that this is a No. 6 wire.

Ques. State how you would test lamp house for grounds?

Ans. Take test lamp and after making sure that there was current in the lamp house (by placing test lamp terminals on carbons) would proceed as follow: Would place one terminal of test lamp on the upper carbon and the other terminal on lamp house, if test lamp lights, then the lower jaw must be grounded, if we do not get a light then lower jaw is O.K. Then we place one of the test lamp terminals on the lower jaw or carbon and the other terminal we place on metal of lamp house, if we get a light then the upper jaw is grounded, if we do not get a light then the upper jaw is O.K. If machine was grounded we would of course remove ground wire before making the test as above.

Ques. Name three essential parts of a dynamo.

Ans. Armature, commutator, field coils.

Ques. What is the object of the field magnets?

Ans. To provide a field of magnetic lines of force to be cut by the armature inductors as they revolve in the field.

Ques. What is an armature?

Ans. A collection of inductors mounted on a shaft and arranged to rotate in a magnetic field with provision for collecting the current induced in the inductors.

A simple loop or turn of wire may be considered as the simplest form of armature.

Ques. What is a commutator?

Ans. A device for causing the alternating currents generated in the armature to flow in the same direction in the external circuit. It consists of a series of copper bars or segments arranged side by side forming a cylinder and insulated from each other by sheets of mica.

Ques. How do armature and field magnets differ in dynamos and alternators?

Ans. In the dynamo the field magnet is the stationary part and the armature revolves. While in an alternator the reverse is the case.

Ques. Name five parts of a dynamo.

Ans. Bed plate, field magnets, armature, commutator, brushes.

Ques. The primary coil of a transformer is supplied with a current of 25 amperes at 2,000 volts, the pressure received from the secondary is 250 volts. What is the current from the secondary coil, taking it for granted that the transformer is 100% efficient?

Ans. Input equals output. Input is 2,000 times 25 equals 50,000 watts. Watts divided by volts equals amperes, so 50,000 divided by 250 equals 200. Therefore the current from the secondary is 200 amperes.

Ques. What is the name of the coil in which the current is induced?

Ans. The secondary.

Ques. Does a transformer take any current when the switch on the lamp side of same is open?

Ans. Yes. A no-load passes through the primary.

Ques. What is meant by an oil cooled transformer?

Ans. A transformer filled with mineral oil to help keep the transformer cool, never used on moving picture work, the fire risk is too great.

Ques. What would cause the breaking of a brand new film while passing through the machine, taking it for granted that the film was handed to you in perfect condition, and that you had just run some six or seven reels of film through the machine without mishap?

Ans. Caused by the emulsion coming off the new film and adhering to the tension bars in gate of machine, which would give undue tension to the film.

Ques. What is meant by fading a picture? When and how is it done?

Ans. Fading is done by the gradual cutting off of the light (either when taking or projecting the picture). The operator fades one reel into the other when changing from one machine to the other. This is accomplished by the dowsers on the machines, by slowly closing one and at the same time slowly opening the other.

Ques. On which coil of an economizer is the greatest wattage?

Ans. As transformers are not 100% efficient there is a loss in transforming the current, this loss amounts to approximately 5% and as the output equals the input less the loss, it will mean that we have more wattage on the primary than on the secondary.

Ques. What is the proper rate of speed of showing a 1,000 feet of film?

Ans. About fifteen to seventeen minutes. Or about sixteen pictures to the second.

Ques. If the machine is running at proper speed (sixteen pictures to the second) about how long is each picture held on the screen?

Ans. For one-sixteenth part of a second *less the time it takes the intermittent sprocket to move the film.*

Ques. Mention some of the different makes of moving picture machines.

Ans. Powers, Simplex, Standard, Motiograph, Baird, Edison, Lubin, Pathe, Kinemacolor, Cameron.

Ques. Which would show the greater saving, a D. C. economizer or rheostats?

Ans. The initial cost of the D. C. economizer would be greater than that of rheostats, but the working cost of the D. C. economizer would show a great saving over that of the rheostats.

Ques. Why are flicker shutters made with two or three blades when only the largest blade is used to cut off the picture from screen while the film is in motion in gate of machine?

Ans. The second and third blades are on to equalize the light.

Ques. What is a wire gauge?

Ans. A gauge used to measure wires.

Ques. What is the difference between Greenfield and B. X.?

Ans. Greenfield is a metal tubing without wires while B. X. is the same tubing with wires.

Ques. What is the difference between a D. C. converter and a rotary converter?

Ans. A D. C. converter converts D. C. to D. C. while the rotary converter converts A. C. to D. C.

Ques. What is meant by a circuit?

Ans. The path in which the current flows.

Ques. What is a closed circuit?

Ans. When all switches, etc., on a line are closed giving the current a continuous path.

Ques. What is meant by insulation?

Ans. Some non-conducting material on or around a conductor to prevent the escape of current.

Ques. Show by sketch how a lens is set and how it works.

Ans. See page 75.

Ques. What is a circuit breaker?

Ans. A switch which opens automatically when the current or pressure exceeds or falls below a certain fixed standard.

Ques. What effect has it by connecting dynamos in series and dynamos in multiple?

Ans. Dynamos in series increase the volts, dynamos in multiple increase the amperes.

Ques. Name a number of good conductors, fair conductors and non-conductors.

Ans. Silver, copper, mercury and aluminum are good conductors. Water, the body, and dry wood are partial conductors and mica, slate, glass are non-conductors.

Ques. What is the inverse of resistance?

Ans. Conductivity.

Ques. State one of the disadvantages of using A. C. for motion picture work.

Ans. Both carbons form a crater and the arc keeps traveling around carbons making it difficult to get a good steady light on screen.

Ques. Of what use is the field magnet in a dynamo?

Ans. To provide a field of lines of force to be cut by the armature inductors.

Ques. State one of the advantages of A. C. over D. C. as far as transmission goes.

Ans. Reduces the cost of transmission by using high voltage and transformers.

Ques. What is the armature?

Ans. A collection of inductors mounted on a shaft and arranged to turn in a magnetic field for collecting the current induced in the inductors.

Ques. What is a commutator?

Ans. A device for causing the alternating currents generated in the armature to flow in the same direction in the external circuit.

Ques. Which end of the lens faces arc?

Ans. The flat or lesser convex end.

Ques. What would you use to scrape off the emulsion from tension bars?

Ans. Copper or any soft metal.

Ques. Where is the most luminous part of an arc?

Ans. In the crater of the positive carbon.

Ques. What causes hissing of an electric arc?

Ans. Feeding carbons too close together, feeding it a higher current than that required for the length of arc employed.

Ques. What is the reason of using a cored carbon in the positive jaw of arc?

Ans. To reduce the voltage required to maintain the arc by lowering the boiling point or the vaporizing temperature of the crater.

Ques. State the advantages of rubber as an insulator.

Ans. It is flexible, fairly strong and waterproof.

Ques. Can you use a bell set to find ground in lamp house?

Ans. Yes. Place one terminal of bell set on upper carbon and other terminal on lamp house frame, if bell rings then the upper jaw is grounded, if no ring then upper jaw is O.K. Then place one terminal of bell set on lower carbon and other terminal on lamp house if bell rings then the lower jaw is grounded, if you do not get a ring then lower jaw is O.K.

Ques. How often would you test lamp house for grounds?

Ans. Before show each day.

Ques. Suppose you found that either the upper or lower jaw was grounded, where would you first look for the trouble?

Ans. Probably the mica insulation has worked out of jaws of lamp.

Ques. Describe fully what is meant by an electric arc.

Ans. Suppose two carbons are connected in an electric circuit, and the circuit closed by touching the tips of the carbons together (striking your arc); on separating these carbons again the circuit will not be broken, providing the space between be not too great, but will be maintained through the arc formed at this point. The current is assumed as passing from the upper carbon (positive) to the lower carbon (negative). We find in a direct current arc that most of the light issues from the tip of the positive carbon, and this portion is called the crater of the arc. The lower carbon becomes pointed as the upper one hollows out to form the crater. The negative carbon is also incandescent, but not to the same extent as the positive. Between the carbons there is a band of violet light (the arc proper) and this is surrounded by a luminous zone of a golden yellow color. The carbons are worn away or consumed by the passage of the current. The positive carbon being consumed about twice as quick as the lower.

With alternating current the upper carbon becomes positive and negative alternately, and there is no chance for a good crater to be formed, both carbons giving off the same amount of light and being consumed at about the same rate.

Ques. What is a voltmeter used for and how would you connect same?

Ans. Use to measure the pressure or voltage, connected in multiple on your line.

Ques. What is an ammeter and how is it connected?

Ans. Used to measure the current or amperage, connected in series on the line.

Ques. State what care you would take of film while it is in your charge.

Ans. Would examine all film before showing, keep each reel in a metal box or can, and keep all these cans in another metal box constructed without solder and with a self-closing door.

Ques. Name three causes of sparking at your motor.

Ans. Dirt, uneven brushes and broken segment in the commutator.

Ques. Under what conditions can you rewind film in the booth?

Ans. Never rewind films in booth while arc is burning, or while audience is in theatre.

Ques. What would you do in case of fire in the booth?

Ans. Stop motor and switch off arc, drop the booth shutters, turn on the house lights, notify manager and try and extinguish fire.

Ques. What precautions would you take to prevent fires?

Ans. Keep all films in fireproof cans, only have the film on the way to the machine exposed at any time, keep booth free from all pieces of film and all combustible material, see that take-up and automatic shutter work O.K., keep lamp house free from all grounds, keep all electrical connections tight, keep machine clean and in good running order, have a bucket of water and one of sand near at hand in booth, place all hot carbons into a bucket of water when you take them from arc lamp.

Ques. How would you adjust the take-up without stopping the machine?

Ans. If the belt was slipping would use a little rosin or tighten up the tension screw, or use the idler pulley if machine was equipped with one. If take-up refused to revolve the bottom reel, would stop machine and fix.

Ques. Why do they ground an all metal machine?
Ans. For safety.

Ques. How would you find the amount of resistance offered by any conductor?
Ans. The resistance of any conductor is equal to its length in feet divided by the area in circular mils multiplied by the resistance per mil-foot (which is 10.5 ohms).

Ques. What is the international ohm?
Ans. The resistance offered by a column of pure mercury 106.3 centimeters in length by one square millimeter in cross section at a temperature of zero centigrade.

Ques. What percentage of light is lost between the arc lamp and the screen?
Ans. Take the crater of arc as 100%, only 33% of this is picked up by the condensers on D. C. (On A. C. the percentage is much less). Then there is a 16% reflection loss (4% at each of the four glass-to-air surfaces of condensers) plus an absorption loss of 9% (absorption loss being reckoned as 6% per inch, and assuming the condenser combination to have an axial thickness of 1½ inch) or in other words the light falling upon the condensers is subjected to a reduction of 25% in passing through them. Thus only 25.75% passes on to the film being projected. About 50% of

this light will be lost passing through the film, so that only 12.85% is sent on to projection lens. In its passage through the objective lens the light is further reduced some 25% in intensity (4% reflection loss at each of the six glass-to-air surfaces) therefore but 9.65% emerges from lens. This is again cut 50% by the flicker shutter, leaving only 4.80% of the original amount emanating from arc lamp for the illumination of the screen picture. Other factors such as the distance to screen and the effective aperture of the objective also enter, so this is only a rough approximation.

Ques. What is a six to one intermittent movement?

Ans. A movement with which each picture on the film is moved into place before the aperture of the projector in an interval of time equal to one-sixth of the period required for a complete revolution of its driving member (cam).

Ques. Is both voltage and amperage used up in arc lamp, or is the voltage used up and amperage returned; or is the voltage returned to dynamo and amperage used up at arc?

Ans. The voltage is used up forcing the amperage through the resistance. The amperage returns to dynamo. This can be proved by connecting an ammeter in your circuit.

Ques. What would be the result if you lost your bottom loop?

Ans. Film would jump or break.

Ques. What regulates the speed of the reels in the upper and lower magazines.

Ans. The top reel is regulated by film tension and the lower is regulated by the tension spring and split pulley.

Ques. Of what use is the flicker shutter on head of machine?

Ans. To cut off the rays of light from screen while the film is in motion in gate.

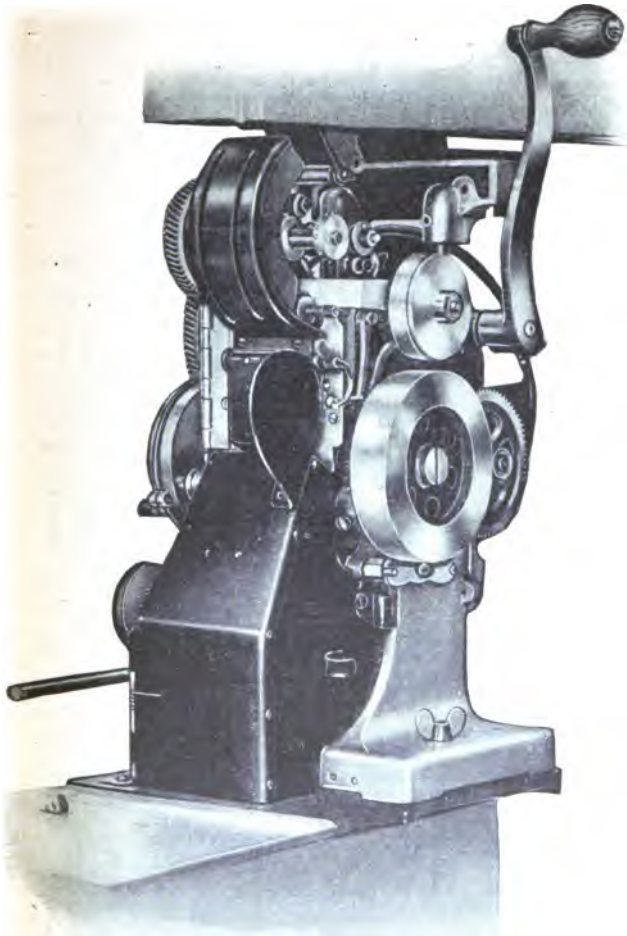
Ques. What causes the film to remain stationary in gate of machine?

Ans. The intermittent movement.

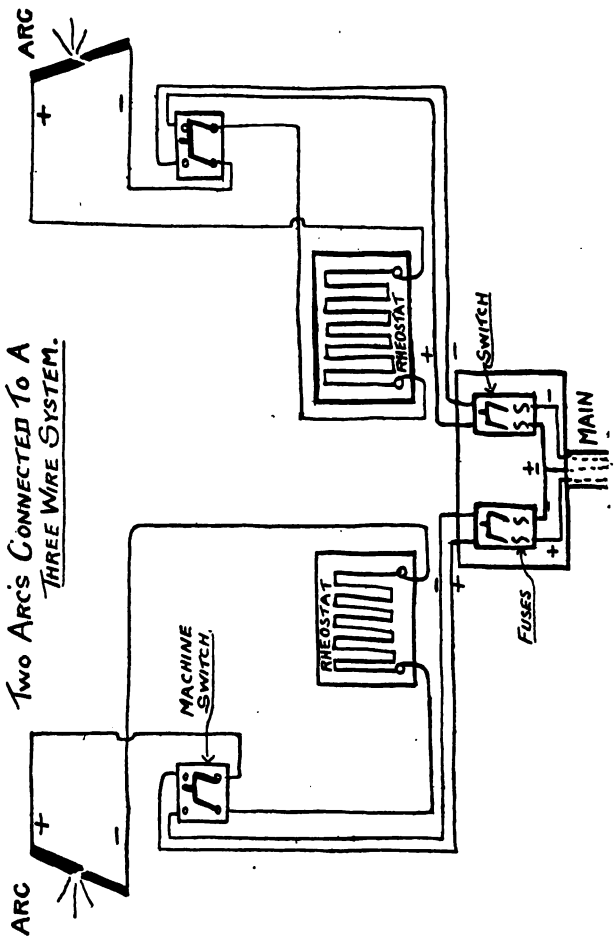
Ques. What is it that works the automatic shutter?

Ans. The centrifugal movement.

B. and S. Gauge



Head of Powers No. 6


TWO ARCS CONNECTED TO A
THREE WIRE SYSTEM.
ARC
ARC
MACHINE SWITCH
RHEOSTAT
RHEOSTAT
SWITCH
MAIN
FUSES
+
-

COPY OF THE RULES ISSUED BY THE DEPARTMENT OF WATER SUPPLY, GAS AND ELECTRICITY NEW YORK CITY

The Operator's License and copy of these rules shall be displayed in a conspicuous place in the booth while the public is in or has access to the premises.

No operator shall conduct an exhibition except where to his knowledge a permit or license of the department of licenses is exhibited on the premises.

The apparatus and its construction shall be tested by the operator prior to each performance. No defective apparatus, or apparatus of a type not approved by this department shall be operated. No apparatus with a lamp served with oxy-hydrogen or acetylene gas shall be approved.

It is forbidden to overfuse (see electrical code, section 418 of the Code of Ordinances) or to make any electrical connections not sanctioned by the aforesaid chapter (see section 438).

The operator shall report promptly every defect in the apparatus or its connection, the correction of which he is unable to secure.

Badly torn films shall not be used and their presence in the booth shall be reported as soon as practical.

The booth at all times shall be kept clean. No pieces of film or loose combustible material shall be allowed to remain in the booth, unless kept in a metal box pro-

vided with a close fitting cover constructed without the use of solder.

The door of the booth shall be kept closed while the public has access to the premises.

No person shall be allowed in the booth except the manager or owner of the premises, a licensed operator, a person specially authorized by the commissioner in writing, or any duly accredited officer of the city.

The interior of the booth shall remain readily accessible to the persons mentioned in the foregoing section. The door of the booth shall not be latched on the inside nor the handle removed from the outside, nor shall any signalling device be permitted which is operated from the front of the house.

No film other than that on the machine or on the rewinder shall be exposed in the booth at any time.

No smoking is permitted in the booth at any time.

No matches, fire or open light is permitted in the booth while the public is on or has access to the house or premises.

Every fire, together with the apparent cause thereof, shall be promptly reported.

Advance report shall be made of the installation of a moving picture machine for a one night exhibition.

The apparatus shall at all times be in charge of a licensed operator.

It is forbidden to operate while under the influence of liquor or drug or to read while operating.

Certificates shall not be loaned or transferred.

POINTS TO REMEMBER

To find the positive or negative polarity when connected up, strike the arc and let same burn for a second or two, then throw off the switch and look to see which of the carbons cool off first. Whichever remains red the longest is the positive and this should always be the carbon in the top jaw of lamp.

If you find that the lower carbon remains red longer than the top, then your lamp is burning upside down, or in other words the positive line is connected to the lower jaw instead of the top. This can be remedied by changing the wires at arc, wall, wall-switch, or table-switch.

Should both carbons remain red the same length of time you have alternating current.

The Department of Water Supply, Gas and Electricity call for the use of link fuses in the operating booth on the machine line. Cartridge fuses are not allowed.

Always see that all connections are tight and that lamp house, etc., is free from grounds.

Examine the lamp leads every so often, remember that copper oxidizes when overheated.

See that you have enough carbon in holders to run the reel through.

When buying or fitting condensers and mounts for same, remember to leave room in mounts for the expansion and contraction of condensers. Remember that cold draughts will break your condensers.

To Set the Flicker Shutter. To set the flicker shutter, loosen up the set screw so that shutter revolves freely on the shaft, now turn shutter till single set screw is in groove of shaft and then tighten, now loosen the two screws on the collar and open the gate of machine. Turn the balance wheel till you see that the intermittent movement is just about to revolve, then the large blade of shutter should just be coming up to cover lens, and should be so fixed that the blade of shutter is covering the front of lens as long as the intermittent sprocket is in motion.

Another way to set it is as follows: Turn the balance wheel till two teeth of the intermittent sprocket has passed a given point, this represents one-half of a picture or in other words that the picture has completed one-half of its movement, now set the large blade of the flicker shutter dead over the front of lens.

Always set the flicker shutter as close to the lens as possible leaving enough room to focus the lens.

Always keep carbon holders clean so that carbons make good contact.

Always have a spare belt (driving and take-up) near at hand.

Keep your fingers off the glass surfaces of lenses.

Oil machine often a little at a time, keep oil off the floor of the booth.

Keep oil off the friction discs.

Never use oil on the arc lamp. Use graphite.

Renew motor brushes, whenever necessary, and keep grease cups filled.

Use your head more and the "One minute please" slide less.

EXAMINATION QUESTIONS

1. Name some of the different lenses used in moving picture work.
2. Under what conditions can you rewind films in the booth?
3. To which end of the table switch (lamp or line) would you connect the primary coil of a transformer?
4. How is a transformer constructed and how does it work?
5. How would you judge what size fuse to use on a line?
6. How is a rheostat made, and what is it used for?
7. Name three kinds of wires used in moving picture work.
8. What is meant by induction?
9. State the difference between an auto transformer and a step-down transformer.
10. How would you ground an all metal machine, and after you have same grounded would you expect to get a light with test lamp if you connected it between either carbon of arc lamp and the lamp house frame?
11. Name three causes of sparking at your motor.
12. What would happen if the neutral fuse on a three wire system was to melt, providing the system was balanced?
13. Explain fully what is meant by a D. C. economizer.
14. Show by sketch the setting of a D. C. arc and a jack-knife setting.

15. Which fuse would you remove first on a three wire system and give reason why?

16. Where is a transverter used on A. C. or D. C.?

17. What is meant by stealing the arc?

18. Is the primary coil of an economizer connected in series or multiple on your line?

19. Is there any difference in the construction of a step-up and a step-down transformer, which is used for moving picture work?

20. Describe fully what regulates the speed of a Powers, Simplex and a Standard machine.

21. Do you get A. C. or D. C. from the secondary coil of a transformer?

22. Does the resistance of metals and carbons increase or decrease with an increase of temperature?

23. What is a rectifier used for?

24. Name the fire prevention devices on the head of machine.

25. What controls the size of the picture on the screen?

26. What precautions would you take before starting your show?

27. How many sets of fuses would you use on your line and what would you call them?

28. Of what use are the condensers?

29. Suppose when you struck the arc the fuse melted where would you look for the trouble?

30. How are the coils in a transformer connected, in multiple or series?

31. What would you do in case of fire?

32. Show by sketch how a lens works and how it is put together?

33. What is the carrying capacity of a No. 6, a No. 8, a No. 14 rubbeer covered wire?

34. Name the mechanical and electrical safety devices on the machine and on the line.

35. What precautions must you take when on a three wire system?

36. Give an easy way to test for A. C. or D. C.

37. What is the back focal length of a lens?

38. Name the advantages and disadvantages of a three wire system. State how a three wire system is obtained.

39. What would you use to change D. C. to A. C.? Is this ever done for moving picture work? If so, state when?

40. What is a keystone effect on screen?

41. What is ohms law?

42. What is a converter and where is it used?

43. What is the difference in construction between a step-down transformer, an economizer, and an inductor?

44. What is meant by current frequency. Do we get current frequency on D. C.?

45. What is a kilowatt, and a circular mil?

46. Show by sketch two rheostats connected in multiple with each other and in series on your line. State where you would use them.

47. With two 110 volt 25 ampere rheostats connected in series, how much resistance (in ohms) will they offer in our circuit?

48. What is an electric arc?

49. Explain how you would test lamp house and rheostat for ground.

50. What size wire would you use for motor connections and what size fuse?

51. Show by sketch two machines connected to one source of supply.

52. On which line, positive or negative, would you connect your rheostat?

53. What is the difference between A. C. and D. C.?

54. State what combination of carbons you would use if you were drawing 50 amperes D. C.

55. Name the principal parts of a dynamo.

56. How do you get the equivalent focus of a lens?

57. Explain what the flicker or light shutter is used for.

58. What is a lug?

59. Name six causes of the film jumping on screen.

60. What is the difference between a short circuit and a ground?

61. State if there would be any saving, if you installed an economizer in place of a rheostat on 110 volt A. C. circuit.

62. State how you would go about measuring a stranded and a solid wire.

63. With two 110 volt 25 ampere rheostats connected in multiple, how much resistance in ohms would they offer on our line?

64. Show by sketch a complete circuit from the main fuses in cellar up to arc lamp, taking it for granted that you have 220 volts D. C. to work on.

65. Show by sketch a complete circuit using a transformer.

66. Suppose the output of a transformer was 2,500 watts, 50 volts, what would be the amount of amperage?

67. If you connected three 110 volt 50 ampere rheostats in series,and connected them on a 220 source of supply what approximate amperage would this give you at arc lamp?

68. What would be the ohmic resistance of three 110 volts 30 ampere rheostats, connected in series?

69. What is the voltage, if we have 4 1-2 ohms resistance on line and are getting 35 amperes at arc lamp.

70. Connected between the neutral and positive wire of a three wire system and with 4 2-5 ohms resistance on circuit, what amperage have we at arc lamp?

71. When and how is fading done?

72. On which coil of a transformer, the primary or secondary, is the most wattage and give your reason for this.

73. State fully what precautions you would take so that you could project a picture free from frame-ups.

74. By what would you judge the proper rate of speed in projecting pictures, how long should it take you to run off a 2000 foot reel?

75. What is the wattage on a mazda lamp used for moving picture projection work?

76. How would you measure a stranded wire?

77. Name six parts on a motor generator and state their uses.

78. What size fuse would you install providing you were connected up on a 220 volt circuit and had two 110 volt 25 ampere rheostats on your line?

79. Name three causes of your film breaking.

80. What lubricant would you use on the following parts of the machine? (*a*) Arc lamp? (*b*) Intermittent movement? (*c*) Gears? (*d*) Motor bearings?